

11
OBSERVATIONS

ON

M A N,

HIS FRAME, HIS DUTY,

AND HIS

EXPECTATIONS.

In TWO PARTS.

PART THE FIRST:

CONTAINING

OBSERVATIONS ON THE FRAME OF THE

HUMAN BODY AND MIND,

AND ON THEIR

MUTUAL CONNEXIONS AND INFLUENCES.

BY DAVID HARTLEY, M.A.

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THE BOOKSELLER'S ADVERTISEMENT.

THE first two volumes of this publication contain Dr. Hartley's work entire, as published by himself in the year 1749, without any alterations or additions.

The third consists of notes and additions to the second volume by a learned German, Mr. Pistorius, which are here faithfully rendered into English, and have been added by the advice of some literary friends, who are well acquainted with the author's work, and thought they would form a valuable addition to it.

A sketch of the life and character of Dr. Hartley, written by his son David Hartley, Esq. is prefixed to the third volume.

For the use of a portrait, from which an engraving has been taken by Mr. Blake, and the liberal encouragement given to the present edition by the author's family, the bookseller returns his thanks.

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T H E

P R E F A C E.

THE work here offered to the public consists of papers written at different times, but taking their rise from the following occasion.

About eighteen years ago I was informed, that the Rev. Mr. GAY, then living, asserted the possibility of deducing all our intellectual pleasures and pains from association. This put me upon considering the power of association. Mr. GAY published his sentiments on this matter, about the same time, in a Dissertation on the fundamental Principle of Virtue, prefixed to Mr. Archdeacon LAW's Translation of Archbishop KING's Origin of Evil.

From inquiring into the power of association I was led to examine both its consequences, in respect of morality and religion, and its physical cause. By degrees many disquisitions foreign to the doctrine of association, or at least not immediately connected with it, intermixed themselves. I have here put together all my separate papers on these subjects,

subjects, digesting them in such order as they seemed naturally to suggest; and adding such things as were necessary to make the whole appear more complete and systematical.

I think, however, that I cannot be called a system-maker, since I did not first form a system, and then suit the facts to it, but was carried on by a train of thoughts from one thing to another, frequently without any express design, or even any previous suspicion of the consequences that might arise. And this was most remarkably the case, in respect of the doctrine of *necessity*; for I was not at all aware, that it followed from that of association, for several years after I had begun my inquiries; nor did I admit it at last without the greatest reluctance.

There are two things in these papers, which require a particular apology. First, The imperfect state in which they are presented to the reader. Secondly, The great freedom which I have used in respect of all orders of men in the conclusion of the second part.

As to the first; If the reader will be so favourable to me as to expect nothing more than hints and conjectures in difficult and obscure matters, and a short detail of the principal reasons and evidences in those that are clear, I hope he will not be much disappointed. However, be this as it will, I have in one part or other of these papers alleged all that I know material, in support of my system; and therefore am now desirous

to

to recommend it to the consideration of others.

I have tried to reconcile such inconsistencies, real or apparent, and to cut off such repetitions and redundancies, as have arisen from my writing the separate parts of this work at different times, and in different situations of mind. But I have still need of great indulgence from the reader on these and other accounts.

As to the second thing; I can truly say, that my free and unreserved manner of speaking has flowed from the sincerity and earnestness of my heart. But I will not undertake to justify all that I have said. Some things may be too hasty and censorious; or, however, be unbecoming my place and station. I heartily wish, that I could have observed the true medium. For, want of candour is not less an offence against the gospel of Christ, than false shame, and want of courage in his cause.

Some persons may perhaps think, that I ought not to have delivered my opinions so freely and openly, concerning the necessity of human actions, and the ultimate happiness of all mankind; but have left the reader to deduce these consequences, or not, as should appear most reasonable to him. But this would, in my opinion, have been a disingenuous procedure. Besides, these tenets appear to me not only innocent, but even highly conducive to the promotion of piety and virtue amongst mankind. However,

that no one may misapprehend me to his own hurt, I will here make two remarks by way of anticipation.

First, then, I no where deny practical free-will, or that voluntary power over our affections and actions, by which we deliberate, suspend, and choose, and which makes an essential part of our ideas of virtue and vice, reward and punishment; but, on the contrary, establish it (if so plain a thing will admit of being farther established) by shewing in what manner it results from the frame of our natures.

Secondly, I do most firmly believe, upon the authority of the scriptures, that the future punishment of the wicked will be exceedingly great both in degree and duration, *i. e.* infinite and eternal, in that real practical sense to which alone our conceptions extend. And were I able to urge any thing upon a profane careless world, which might convince them of the infinite hazard to which they expose themselves, I would not fail to do it, as the reader may judge even from those passages for which I have above apologized,

DECEMBER, 1748.

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O B S E R V A T I O N S

O N

M A N, &c.

I N T W O P A R T S.

P A R T I.

containing OBSERVATIONS *on the FRAME of the HUMAN*
BODY *and* MIND, *and on their* MUTUAL CONNec-
TIONS *and* INFLUENCES.

I N T R O D U C T I O N.

M A N consists of two parts, body and mind.

The first is subjected to our senses and inquiries,
in the same manner as the other parts of the external
material world.

The last is that substance, agent, principle, &c.
to which we refer the sensations, ideas, pleasures,
passions, and voluntary motions.

Sensations are those internal feelings of the mind,
which arise from the impressions made by external
objects upon the several parts of our bodies.

VOL. I.

B

All

All our other internal feelings may be called *ideas*. Some of these appear to spring up in the mind of themselves, some are suggested by words, others arise in other ways. Many writers comprehend *sensations* under *ideas*; but I every where use these words in the senses here ascribed to them.

The *ideas* which resemble sensations, are called *ideas of sensation*: all the rest may therefore be called *intellectual ideas*.

It will appear in the course of these observations, that the *ideas of sensation* are the elements of which all the rest are compounded. Hence *ideas of sensation* may be termed *simple*, *intellectual* ones *complex*.

The *pleasures* and *pains* are comprehended under the sensations and ideas, as these are explained above. For all our pleasures and pains are internal feelings, and, conversely, all our internal feelings seem to be attended with some degree either of *pleasure* or *pain*. However, I shall, for the most part, give the names of *pleasure* and *pain* only to such degrees as are considerable; referring all low, evanescent ones to the head of *mere sensations* and *ideas*.

The pleasures and pains may be ranged under seven general classes, viz.

1. Sensation;
2. Imagination;
3. Ambition;
4. Self-interest;
5. Sympathy;
6. Theopathy; and,
7. The moral sense; according as they arise from,
 1. The impressions made on the external senses;
 2. Natural or artificial beauty or deformity;
 3. The opinions of others concerning us;
 4. Our possession or want of the means of happiness, and security from, or subjection to, the hazards of misery;

5. The pleasures and pains of our fellow-creatures;

6. The affections excited in us by the contemplation of the Deity; or,

7. Moral beauty and deformity.

The human mind may also be considered as indued with the faculties of *memory*, *imagination* or *fancy*, *understanding*, *affection*, and *will*.

Memory is that faculty, by which traces of sensations and ideas recur, or are recalled, in the same order and proportion, accurately or nearly, as they were once actually presented.

When ideas, and trains of ideas, occur, or are called up, in a vivid manner, and without regard to the order of former actual impressions and perceptions, this is said to be done by the power of *imagination* or *fancy*.

The *understanding* is that faculty, by which we contemplate mere sensations and ideas, pursue truth, and assent to, or dissent from, propositions.

The *affections* have the pleasures and pains for their objects; as the *understanding* has the mere sensations and ideas. By the affections we are excited to pursue happiness, and all its means, fly from misery, and all its apparent causes.

The *will* is that state of mind, which is immediately previous to, and causes, those express acts of memory, fancy, and bodily motion, which are termed *voluntary*.

The *motions* of the body are of two kinds, *automatic* and *voluntary*. The *automatic* motions are those which arise from the mechanism of the body in an evident manner. They are called *automatic*, from their resemblance to the motions of *automata*, or machines, whose principle of motion is within themselves. Of this kind are the motion of the heart, and peristaltic motion of the bowels. The *voluntary motions* are those which arise from ideas and affections, and

which therefore are referred to the mind; the immediately preceding state of the mind, or of the ideas and affections, being termed *will*, as noted in the last article. Such are the actions of walking, handling, speaking, &c. when attended to, and performed with an express design.

This may serve as a short account of the chief subjects considered in the first part of these *observations*. These subjects are so much involved in each other, that it is difficult, or even impossible, to begin any where upon clear ground, or so as to proceed entirely from the *Data* to the *Quæsitæ*, from things known to such as are unknown. I will endeavour it as much as I can, and for that purpose shall observe the following order.

First, I shall lay down the general laws, according to which the sensations and motions are performed, and our ideas generated.

Secondly, I shall consider each of the sensations and motions in particular, and inquire how far the phænomena of each illustrate, and are illustrated by, the foregoing general laws.

Thirdly, I shall proceed in like manner to the particular phænomena of ideas, or of understanding, affection, memory, and imagination; applying to them what has been before delivered.

Lastly, I shall endeavour to give a particular history and analysis of the six classes of intellectual pleasures and pains, viz. those of imagination, ambition, self-interest, sympathy, theopathy, and the moral sense.

OF THE
DOCTRINES OF VIBRATIONS
AND
ASSOCIATION IN GENERAL.

C H A P. I.

Of the GENERAL LAWS according to which the SENSATIONS and MOTIONS are performed, and our IDEAS GENERATED.

My chief design in the following chapter, is, briefly, to explain, establish, and apply the doctrines of *vibrations* and *association*. The first of these doctrines is taken from the hints concerning the performance of sensation and motion, which Sir *Isaac Newton* has given at the end of his *Principia*, and in the *questions* annexed to his *Optics*; the last, from what Mr. *Locke*, and other ingenious persons since his time have delivered concerning the influence of *association* over our opinions and affections, and its use in explaining those things in an accurate and precise way, which are commonly referred to the power of habit and custom, in a general and indeterminate one.

The doctrine of *vibrations* may appear at first sight to have no connection with that of *association*; however, if these doctrines be found in fact to contain the laws of the bodily and mental powers respectively, they must be related to each other, since the body and mind are. One may expect, that *vibrations* should infer *association* as their effect, and *association* point to *vibrations* as its cause. I will endeavour, in the present chapter, to trace out this mutual relation.

The proper method of philosophizing seems to be, to discover and establish the general laws of action, affecting the subject under consideration, from certain select, well-defined, and well-attested phænomena, and then to explain and predict the other phænomena by these laws. This is the method of analysis and synthesis recommended and followed by Sir *Isaac Newton*.

I shall not be able to execute, with any accuracy, what the reader might expect of this kind, in respect of the doctrines of *vibrations* and *association*, and their general laws, on account of the great intricacy, extensiveness, and novelty of the subject. However, I will attempt a sketch in the best manner I can, for the service of future inquirers.

S E C T. I.

OF THE DOCTRINE OF VIBRATIONS, AND ITS
USE FOR EXPLAINING THE SENSATIONS.

P R O P. I.

The white medullary Substance of the Brain, spinal Marrow, and the Nerves proceeding from them, is the immediate Instrument of Sensation and Motion.

UNDER the word *brain*, in these observations, I comprehend all that lies within the cavity of the skull, *i. e.* the *cerebrum*, or *brain* properly so called, the *cerebellum*, and the *medulla oblongata*.

This proposition seems to be sufficiently proved in the writings of physicians and anatomists; from the structure and functions of the several organs of the human body; from experiments on living animals; from the symptoms of diseases, and from dissections of morbid bodies. Sensibility, and the power of motion, seem to be conveyed to all the parts, in their natural state, from the brain and spinal marrow, along the nerves. These arise from the medullary, not the cortical part, every where, and are themselves of a white medullary substance. When the nerves of any part are cut, tied, or compressed in any considerable degree, the functions of that part are either entirely destroyed, or much impaired. When the spinal marrow is compressed by a dislocation of the *vertebræ* of the back, all the parts, whose nerves arise below the place of dislocation, become paralytic. When any consider-

able injury is done to the medullary substance of the brain, sensation, voluntary motion, memory, and intellect, are either entirely lost, or much impaired; and if the injury be very great, this extends immediately to the vital motions also, viz. to those of the heart, and organs of respiration, so as to occasion death. But this does not hold equally in respect of the cortical substance of the brain; perhaps not at all, unless as far as injuries done to it extend themselves to the medullary substance. In dissections after apoplexies, palsies, epilepsies, and other distempers affecting the sensations and motions, it is usual to find some great disorder in the brain, from preternatural tumors, from blood, matter, or serum, lying upon the brain, or in its ventricles, &c. This may suffice as general evidence for the present. The particular reasons of some of these phænomena, with more definite evidences, will offer themselves in the course of these observations.

P R O P. II.

The white medullary Substance of the Brain is also the immediate Instrument, by which Ideas are presented to the Mind: or, in other Words, whatever Changes are made in this Substance, corresponding Changes are made in our Ideas; and vice versa.

THE evidence for this proposition is also to be taken from the writings of physicians and anatomists; but especially from those parts of these writings, which treat of the faculties of memory, attention, imagination, &c. and of mental disorders. It is sufficiently manifest from hence, that the perfection of our mental faculties depends upon the perfection of this substance; that all injuries done to it, affect the trains of ideas proportionably; and that these cannot

cannot be restored to their natural course, till such injuries be repaired. Poisons, spirituous liquors, opiates, fevers, blows upon the head, &c. all plainly affect the mind, by first disordering the medullary substance. And evacuations, rest, medicines, time, &c. as plainly restore the mind to its former state, by reversing the foregoing steps. But there will be more and more definite evidence offered in the course of these observations.

P R O P. III.

The Sensations remain in the Mind for a short Time after the sensible Objects are removed.

THIS is very evident in the sensations impressed on the eye. Thus, to use Sir Isaac Newton's words, "If a burning coal be nimbly moved round in a circle, with gyrations continually repeated, the whole circle will appear like fire; the reason of which is, that the sensation of the coal, in the several places of that circle, *remains impressed on the sensorium*, until the coal return again to the same place. And so in a quick consecution of the colours" (viz. red, yellow, green, blue, and purple, mentioned in the experiment, whence this passage is taken) "the impression of every colour *remains on the sensorium*, until a revolution of all the colours be completed; and that first colour return again. The impressions therefore of all the successive colours, *are at once in the sensorium*—and beget a sensation of white." *Opt. B. I. p. 2. Experiment 10.*

Thus also, when a person has had a candle, a window, or any other lucid and well-defined object, before

before his eyes, for a considerable time, he may perceive a very clear and precise image thereof to be left in the *sensorium*, fancy, or mind (for these I consider as equivalent expressions in our entrance upon these disquisitions), for some time after he has closed his eyes. At least this will happen frequently to persons, who are attentive to these things, in a gentle way: for as this appearance escapes the notice of those who are entirely inattentive, so too earnest a desire and attention prevents it, by introducing another state of mind or fancy.

To these may be referred the appearance mentioned by Sir *Isaac Newton*, *Opt. Qu.* 16. viz. "When a man in the dark presses either corner of his eye with his finger, and turns his eye away from his finger, he will see a circle of colours like those in the feather of a peacock's tail. And this appearance continues about a second of time, after the eye and finger have remained quiet." The sensation continues therefore in the mind about a second of time after its cause ceases to act.

The same continuance of the sensations is also evident in the ear. For the sounds which we hear, are reflected by the neighbouring bodies; and therefore consist of a variety of sounds, succeeding each other at different distances of time, according to the distances of the several reflecting bodies; which yet causes no confusion, or apparent complexity of sound, unless the distance of the reflecting bodies be very considerable, as in spacious buildings. Much less are we able to distinguish the successive pulses of the air, even in the gravest sounds.

As to the senses of taste and smell, there seems to be no clear direct evidence for the continuance of their sensations, after the proper objects are removed. But analogy would incline one to believe, that they must resemble the senses of sight and hearing in this particular, though the continuance cannot

cannot be perceived distinctly, on account of the shortness of it, or other circumstances. For the sensations must be supposed to bear such an analogy to each other, and so to depend in common upon the brain, that all evidences for the continuance of sensations in any one sense, will extend themselves to the rest. Thus all the senses may be considered as many kinds of feeling; the taste is nearly allied to the feeling, the smell to the taste, and the sight and hearing to each other. All which analogies will offer themselves to view, when we come to examine each of these senses in particular.

In the sense of feeling, the continuance of heat, after the heating body is removed, and that of the smart of a wound, after the instant of infliction, seem to be of the same kind with the appearances taken notice of in the eye and ear.

But the greatest part of the sensations of this sense resemble those of taste and smell, and vanish to appearance as soon as the objects are removed.

P R O P. IV.

External Objects impressed upon the Senses occasion, first in the Nerves on which they are impressed, and then in the Brain, Vibrations of the small, and, as one may say, infinitesimal, medullary Particles.

THESE vibrations are motions backwards and forwards of the small particles; of the same kind with the oscillations of pendulums, and the tremblings of the particles of sounding bodies. They must be conceived to be exceedingly short and small, so as not to have the least efficacy to disturb or move the whole bodies of the nerves or brain. or that the nerves themselves should vibrate like musical

musical strings, is highly absurd; nor was it ever asserted by Sir *Isaac Newton*, or any of those who have embraced his notion of the performance of sensation and motion, by means of *vibrations*.

In like manner, we are to suppose the particles which vibrate, to be of the inferior orders, and not those biggest particles, on which the operations in chemistry, and the colours of natural bodies, depend, according to the opinion of Sir *Isaac Newton*. Hence, in the *proposition*, I term the medullary particles, which vibrate, *infinitesimal*.

Now that external objects impress vibratory motions upon the medullary substance of the nerves and brain (which is the immediate instrument of sensation, according to the *first proposition*), appears from the continuance of the sensations mentioned in the third; since no motion, besides a vibratory one, can reside in any part for the least moment of time. External objects, being corporeal, can act upon the nerves and brain, which are also corporeal, by nothing but impressing motion on them. A vibrating motion may continue for a short time in the small medullary particles of the nerves and brain, without disturbing them, and after a short time would cease; and so would correspond to the above-mentioned short continuance of the sensations; and there seems to be no other species of motion that can correspond thereto.

COR. As this *proposition* is deduced from the foregoing, so if it could be established upon independent principles (of which I shall treat under the next), the foregoing might be deduced from it. And, on this supposition, there would be an argument for the continuance of the sensations, after the removal of their objects; which would extend to the senses of feeling, taste, and smell, in the same manner as to those of sight and hearing.

P R O P. V.

The Vibrations mentioned in the last Proposition are excited, propagated, and kept up, partly by the Æther, i. e. by a very subtle and elastic Fluid, and partly by the Uniformity, Continuity, Softness, and active Powers of the medullary Substance of the Brain, spinal Marrow, and Nerves.

THIS *proposition* is chiefly an evidence and explanation of the foregoing; and accordingly might have been included in it. However, as it is of great importance in the present subject, I thought it best to give it a distinct place and consideration.

Before I enter upon the proof of it, it will be proper to premise something by way of explanation, concerning the æther, and the qualities of the medullary substance just mentioned.

Sir *Isaac Newton* supposes, that a very subtle and elastic fluid, which he calls *æther*, for the sake of creating upon it commodiously under an appropriated name, is diffused through the pores of gross bodies, as well as through the open spaces, that are void of gross matter. He supposes likewise, that it is rarer in the pores of bodies than in open spaces, and even rarer in small pores and dense bodies, than in large pores and rare bodies; and also, that its density increases in receding from gross matter, so, for instance, as to be greater at the $\frac{1}{100}$ of an inch from the surface of any body than at its surface; and so on. To the action of this æther he ascribes the attractions of gravitation and cohesion, the attractions and repulsions of electrical bodies, the mutual influences of bodies and light upon each other, the effects and communication of heat, and the performance of animal sensation and motion. My business
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in these *observations*, is only with the last; but the reader will do well to consult what Sir *Isaac Newton* has himself advanced concerning the existence of this æther, and the properties and powers which he has ascribed to it, in the last paragraph of his *Principia*, the *Questions* annexed to his *Optics*, and a *Letter* from him to Mr. *Boyle*, lately published in Mr. *Boyle's* Life. As to myself, I am not satisfied, that I understand him perfectly on this subject. I will hint a few things partly from him, partly from my own reflections, concerning the existence and properties of this æther.

Since a thermometer kept, *in vacuo*, varies with the heat and cold of the room, in which it is placed, as much as another surrounded by air; and since the small parts of hot bodies probably vibrate to and fro, and by thus vibrating keep up the heat for a certain time; one may conjecture, that a subtle medium remains after the air is exhausted, and that heat is communicated to the thermometer suspended *in vacuo* by the vibrating motions of this medium. See *Opt. Qu.* 18.

The greater density of the æther at a distance from bodies than at their surface, may be conjectured from the various phænomena solved by this supposition; which phænomena may also be alleged as probable evidences of the existence of the æther. See *Opt. Qu.* and the *Letter to Mr. Boyle*.

The great subtlety and elasticity of the æther may be inferred from the motions of the planets, and quick propagation of light, if we first suppose its existence, and concurrence in the propagation of light, and efficacy in causing gravity. And from its great elasticity we may infer, that it is extremely susceptible of vibrations and pulses, in the same manner as common air. See *Opt. Quer.*

Since the gross bodies that lie upon the surface of the earth emit air particles, constituting a thin, elastic

elastic fluid, of great efficacy in performing the ordinary operations of nature, it seems not unnatural to expect, that the small particles of bodies should emit a proportionably attenuated air, *i. e.* an æther, which may likewise have a great share in the subtle actions of the small particles of bodies over each other. The emission of odoriferous particles, light, magnetical and electrical effluvia, may also be some presumption in favour of the existence of the æther. Moreover, it is reasonable to expect, that it should have a repulsive force in respect of the bodies which emit it; and for the same reasons, its particles may repel each other. It may therefore be elastic, compressible, and apt to receive vibrations from the last cause; and, from the first, may be rarer within the pores of bodies than in large open spaces, and grow denser as the distance from gross matter increases. Our air is indeed denser near the earth than in the higher regions; but this is owing to its gravity, prevailing against its expansive force. If we suppose the gravity of the æther to be very small, and its elasticity or expansive and repulsive force very great, both which must be supposed, if we admit it at all in the manner proposed by Sir *Isaac Newton*, its density may increase in receding from gross matter, and be much less in the pores of bodies, than in open spaces void of gross matter. Thus we may suppose even the air, which remains in the large pores of such bodies as repel its particles, to be rarer than the common external air.

Lastly, Let us suppose the existence of the æther, with these its properties, to be destitute of all direct evidence, still, if it serves to explain and account for a great variety of phænomena, it will have an indirect evidence in its favour by this means. Thus we admit the key of a cypher to be a true one, when it explains the cypher completely; and the decypherer judges himself to approach to the true key, in proportion

portion as he advances in the explanation of the cypher; and this without any direct evidence at all. And as the false and imperfect keys, which turn up to the decypherer in his researches, prepare the way for the discovery of the true and complete one, so any hypothesis that has so much plausibility, as to explain a considerable number of facts, helps us to digest these facts in proper order, to bring new ones to light, and to make *Experimenta Crucis* for the sake of future inquirers. The rule of false affords an obvious and strong instance of the possibility of being led, with precision and certainty to a true conclusion from a false position; and it is of the very essence of algebra to proceed in the way of supposition.

We come next to consider the uniformity and continuity of the white medullary substance of the brain, spinal marrow, and nerves. Now these are evident to the eye, as far as that can be a judge of them. The white medullary substance appears to be every where uniform and similar to itself throughout the whole brain, spinal marrow, and nerves; and though the cortical substance be mixed with the medullary in the brain, and spinal marrow, and perhaps in the ganglions and plexuses, yet it does not appear, that the communication of any one part of the medullary substance with every other, is cut off any where by the intervention of the cortical. There is no part of the medullary substance separated from the rest, but all make one continuous white body; so that if we suppose vibrations apt to run freely along this body from its uniformity, they must pervade the whole, in whatever part they are first excited, from its continuity.

The excessive minuteness of the vessels of which the medullary substance consists, may also be conceived as inferring its uniformity and continuity. These vessels are, by all anatomists and physiologists,

gifts, supposed to arise from those of the cortical substance, this being agreeable to the analogy of the other parts of the body. And it follows from the same analogy, that they must be smaller than those vessels from which they arise. But the finer orders of the vessels of the cortical substance are far too minute to admit of the most subtle injections, the best injectors having never penetrated farther than the grosser orders of vessels in the cortical substance. We may therefore well suppose, that the medullary substance consists of a texture of vessels so small and regular, as that it may have no vacuity or interval in it, sufficient to interrupt or disturb the vibrations of the æther, and concomitant ones of the small medullary particles, propagated through this substance in the manner to be described below.

The softness of the medullary substance is, in like manner, evident to the senses, and the natural consequence of the extreme smallness of the compound vessels, and fluids circulating through them.

If we admit the foregoing account of the uniform continuous texture of the medullary substance, it will follow, that the nerves are rather solid capillaments, according to Sir *Isaac Newton*, than small *tubuli*, according to *Boerhaave*. And the same conclusion arises from admitting the doctrine of *vibrations*. The *vibrations* hereafter to be described may more easily be conceived to be propagated along solid capillaments, so uniform in their texture as to be pellucid when singly taken, than a long hollow *tubuli*. For the same reasons, the doctrine of *vibrations* will scarce permit us to suppose the brain to be a gland properly so called; since the difformity of texture required in a gland, appears inconsistent with the free propagation of vibrations. Neither can we conclude the brain to be a gland, from the great quantity of blood sent to it by the heart. It is probable indeed, that this is required on account of the important

functions of accretion, nutrition, sensation, and motion, which are plainly performed by the brain. But then these functions admit of as easy an explanation on the hypothesis here proposed, as on that of a glandular secretion, called nervous fluid, animal spirits, &c. In the mean time, I cannot but acknowledge many, or even most things, in the *Boerhaavian* doctrine concerning the structure and functions of the brain, to be beautiful, just, and useful. And it may even be, that the doctrine of a glandular secretion, properly qualified, is not inconsistent with that of vibrations.

Sir *Isaac Newton* supposes the nerves, when singly taken, to be pellucid, because otherwise they could not be sufficiently uniform for the purpose of transmitting vibrations freely to and from the brain; the opacity of any body being, according to him, an argument, that its pores are so large and irregular, as to disturb and interrupt the vibrations of the æther. For the same reasons, we must suppose the fibrils of the medullary substance of the brain to be pellucid, when singly taken. And this consideration may incline one to conjecture, that, in palsies, the infinitesimal vessels of the fibrils of the brain, and capillaments of the nerves, are so obstructed, as to render these fibrils and capillaments white and opaque, in the same manner as the hair in old age, or the *Cornea* in an *Albugo*.

Since the *Pia Mater*, with its blood vessels, enters the interstices of the several folds of the brain, one may suspect, that it penetrates not only the cortical substance, but also the medullary, along with the several descending orders of vessels, and consequently that it divides and subdivides the medullary substance into various greater and lesser regions. One may affirm at least, that such a distribution of the *Pia Mater* would be greatly analagous to that of the cellular membrane, through the system of muscles, their
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separate portions, fibres, and fibrils. But then we may reasonably suppose the *Pia Mater* to be so attenuated in these its processes, as that the medullary substance may still remain sufficiently uniform for the free propagation of vibrations. Or, if there be some little impediment and confinement in certain regions, on account of some exceedingly small continuity, arising from this intervention of the *Pia Mater* between certain regions, it may, as it seems to me, suit this theory rather better than an absolute and perfect continuity, as before supposed. It is reasonable also to think, that the nerves of different parts have innumerable communications with each other in the brain, in the ganglions (which are, as it were, little brains, according to the opinion of *Winslow*), and even in the plexuses; and that many phænomena, particularly those of the sympathetic kind, are deducible from these communications. But as it seems impossible to trace out these communications anatomically, on account of the great softness of the brain, we must content ourselves with such conjectures as the phænomena shall suggest, trying them by one another, and admitting for the present those which appear most consistent upon the whole, till farther light appears. The same, or even a greater, obscurity attends all inquiries into the uses of the particular shape and protuberances of the medullary substance of the brain.

We come, in the last place, to consider what active properties may belong to the small particles of the medullary substance, *i. e.* to the small particles which compose either the ultimate vessels of this substance, or the fluid which circulates in these ultimate vessels. The common doctrine concerning the powers of the nervous system supposes the fluid secreted by, and circulating through, the medullary substance, to be of a very active nature; and this may be, though the taste of the medullary substance in brute animals discovers no such activity. For the power of

impreſſing taſtes ſeems to reſide in particles much larger than thoſe which we are here conſidering. And it is ſufficiently obvious, that many poiſons, mineral, vegetable, and animal, have the moſt active properties concealed under inſipid, or at leaſt moderate flavours. Now that ſome powers of attraction or repulſion, or rather of both at different diſtances, reſide in the ſmall particles of the medullary ſubſtance, can ſcarce be doubted after ſo many inſtances and evidences, as Sir *Iſaac Newton* has produced, of attractive and repulſive powers in the ſmall particles of various bodies, *Optics*, *Query* 31. meaning, as he does, by attraction and repulſion, a mere mathematical tendency to approach and recede, be the cauſe what it will, impulſe, preſſure, an unknown one, or no phyſical cauſe at all, but the immediate agency of the Deity. The ſmallneſs alſo of the particles of the medullary ſubſtance may not improbably increaſe their activity, in reſpect of their bulk, agreeably to Sir *Iſaac Newton's* conjecture concerning the particles of the æther. Which may be farther inferred from the nature of theſe attractions and repulſions; for ſince they ſeem to be as ſome reciprocal power of the diſtance, we may judge, that only the neareſt parts of large particles will be eminently active, and that the more remote ones will be an impediment to their actions; whence ſmall particles, having nearly as great active powers, and much leſs matter to be moved, will, upon the whole, be more active in proportion to their bulk, than large ones. If we farther ſuppoſe the particles of the fluids, which circulate through the ultimate veſſels of the medullary ſubſtance, to be ſmaller than the particles which compoſe theſe veſſels, then will they alſo be more active. And thus we ſeem to approach to all that is probable in the received doctrines concerning the nervous fluid, and the animal ſpirits, ſuppoſed to be either the ſame or different things; and all the arguments which *Boerhaave*

have brought for his hypothesis, of a glandular secretion of a very subtle active fluid in the brain, may be accommodated to the *Newtonian* hypothesis of vibrations.

Having thus endeavoured to settle our notions concerning the æther, and establish our evidences for its existence and properties, and for the uniformity, continuity, softness, and active powers of the medullary substance, we come, in the next place, to inquire in what manner these may serve to explain or evince the vibrations of the medullary particles, asserted in the foregoing *proposition*.

First then, We are to conceive, that when external objects are impressed on the sensory nerves, they excite vibrations in the æther residing in the pores of these nerves, by means of the mutual actions interceding between the objects, nerves, and æther. For there seem to be mutual actions of all the varieties between these three, in all the senses, though of a different nature in different senses. Thus it seems, that light affects both the optic nerve and the æther; and also, that the affections of the æther are communicated to the optic nerve, and *vice versa*. And the same may be observed of frictions of the skin, tastes, smells, and sounds. The impulse, attraction, or whatever else be the action of the object, affects both the nerves and the æther; these affect each other, and even the object or impression itself, in most or all cases, so as to alter or modify it. And the result of these actions, upon the whole, may be supposed such a compression or increase of density in the æther, as must agitate its particles with vibrations analogous to those which are excited in the air by the discharge of guns, by thunder-claps, or by any other method of causing a sudden and violent compression in it.

Secondly, We are to conceive, that the vibrations thus excited in the æther will agitate the small particles

ticles of the medullary substance of the sensory nerves with synchronous vibrations, in the same manner as the vibrations of the air in sounds agitate many regular bodies with corresponding vibrations or tremblings. And here the uniformity, softness, and active powers of the medullary substance, must be considered as previous requisites and assistances. A want of uniformity in the medullary substance, would argue a like want of uniformity in the æther contained within it. The hardness of it, if it extended to the particles, would cause an ineptitude to vibratory motions in the particles of these particles, *i. e.* in the infinitesimal particles considered in this and the foregoing *proposition*. And a want of active powers in these particles would suffer the excited motions to die away prematurely.

One may conjecture, indeed, that the rays of light excite vibrations in the small particles of the optic nerve, by a direct and immediate action. For it seems probable, from the alternate fits of easy transmission and reflection, that the rays of light are themselves agitated by very subtle vibrations, and consequently that they must communicate these directly and immediately to the particles of the optic nerves. And it may be also, that sapid and odoriferous particles are agitated with specific vibrations, and that they communicate these directly and immediately to the small particles of the gustatory and olfactory nerves respectively, as well as to the interjacent æther. Upon this supposition, the vibrations of the æther must be conceived as regulating and supporting the vibrations of the particles, not as exciting them originally.

Thirdly, The vibrations thus excited in the æther, and particles of the sensory nerves, will be propagated along the course of these nerves up to the brain. For the æther residing in the medullary substance, being of an uniform density on account of the

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the smallness of the pores of the medullary substance, and uniformity of its texture, before taken notice of, will suffer the excited vibrations to run freely through it. And the same uniformity, together with the continuity, softness, and active powers, of the medullary substance, will farther contribute to the free propagation of the vibrations; since, on these accounts, it follows, that the particles, which were last agitated, may easily communicate their agitations or vibrations to the similarly posited and equal contiguous ones, without interruption, and almost without any diminution of force. This free propagation of vibrations along the course of the nerves may be illustrated and confirmed by the like free propagation of sounds along the surface of water, which has sometimes been observed in still, calm nights.

Fourthly, The vibrations here described are confined to the medullary substance, or at least are only propagated feebly and imperfectly into the neighbouring parts, on account of the heterogeneity and greater hardness of the neighbouring parts. The first will make the æther of different densities, and, in some cases, there may be almost an interruption or discontinuity of it; and the last will indispose the particles to receive and communicate vibrations; and we may suppose from both together, agreeably to what has been already remarked, that only small vibrations, and such irregular ones as oppose each other, will just begin to take place in the immediately contiguous parts, and there cease without proceeding farther. It is somewhat analogous to this in sounds, that they are much sooner lost in passing over rough surfaces than smooth ones; and particularly, that they receive a much greater diminution from the irregular surface of the earth, than from that of still water. However, a particular exception is here to be made in respect of the fibres of the muscles and membranes, into
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which the vibrations of the æther and medullary particles seem to be propagated with great freedom and strength, as will be seen hereafter. Which may perhaps be some argument, that muscular fibres are, according to *Boerhaave's* opinion, mere productions of the ultimate nerves.

Fifthly, As soon as the vibrations enter the brain, they begin to be propagated freely every way over the whole medullary substance; being diminished in strength, in proportion to the quantity of matter agitated, just as in sounds, *i. e.* as it were in a reciprocal duplicate *ratio* of the distance from the place where the sensory nerve affected by the vibrations enters the brain. Or, if we suppose the *Pia Mater* to make some small discontinuity in the medullary substance by its processes, as has been hinted above, then we must also suppose, that the vibrations, which ascend along any sensory nerve, affect the region of the brain which corresponds to this sensory nerve more, and the other regions less, than according to this proportion.

Sixthly, Since the vibrations, or reciprocal motions, of the small particles of each nerve are made in the same line of direction with the nerve, they must enter the brain in that direction, and may preserve some small regard to this direction at considerable distances within the brain; especially if this be favoured by the structure of the nervous fibrils in the brain. Hence the same internal parts of the brain may be made to vibrate in different directions, according to the different directions of the nerves by which the vibrations enter.

And thus it appears, that, admitting the existence and subtlety of the æther, and the qualities of the medullary substance here alleged, a probable account may be given, how the vibrations, asserted in the last proposition, may be excited in the sensory nerves, and propagated thence over the whole medullary substance,

stance, and over that alone. And the suitableness of this proposition to the last, and of both to a variety of phænomena, which will be seen in the course of these observations, may be considered as some evidence for both.

Let it be remarked also, that, if the performance of sensation by vibratory motions of the medullary particles be admitted, the existence of a subtle elastic fluid must be admitted in consequence thereof, as the only means that can be conceived for their rise and free propagation, so as to answer to the phænomena of sense, motion, and ideas; and reciprocally, if the existence of so subtle and elastic a fluid, as the æther described by Sir *Isaac Newton*, can be established upon independent principles, it may reasonably be supposed to penetrate the pores of the medullary substance, how small soever they be, in the same manner as air penetrates grosser cavities and pores, and, like air, both be itself agitated by vibrations from a variety of causes, and also communicate these to the medullary particles. We may therefore either deduce the doctrine of vibrations here proposed from the consideration of the æther, or the existence of the æther from the doctrine of vibrations, according as either of these can be first established.

There is also some light and evidence to be cast upon one or both of these propositions, from several natural phænomena; as I will endeavour to shew in the following remarks.

1. Heat in natural bodies is probably attended by vibrations of the small parts. This may be inferred from the duration and gradual declension of heat, and from the gross general proportion which is observed between this duration and the density of the heated body. For a vibratory motion would subsist for some time, decline gradually, and be kept up longer, *ceteris paribus*, where the number of vibrating particles were many, than where few. The same

same hypothesis is well suited to the rarefaction, fluidity, dissolution, and other changes of texture which heat produces in bodies, according to their various natures. And if we farther consider, that all bodies, contiguous to each other, come, after a short time, to the same degree of heat, viz. that of the circumambient air; those which are hotter losing something, and those which are colder gaining; and yet that the air is not necessary for the conveyance of heat, as appears from Sir *Isaac Newton's* experiment of the two thermometers above-mentioned; it will appear highly probable, both that heat in bodies is attended by vibratory motions of the small parts, and also that these are communicated to contiguous bodies by vibrations of a subtle fluid, by an argument something different from that urged above, in speaking of the two thermometers; at least the consideration of the equality of temperature, to which all contiguous bodies are known, by common observations, to arrive, will cast some light upon that argument. And, upon the whole, it will follow, that heat in us is caused, or attended, by subtle vibrations of the medullary substance, which is the immediate instrument of all the sensations; and that a subtle fluid is concerned in the production of this effect. And what is thus proved of heat, may be inferred to hold in respect of all the other sensations, from the argument of analogy.

2. Light is so nearly related to heat, that we must suppose the argument of analogy to be particularly strong in respect of it: but, besides this, we have an independent argument for the existence of vibrations here, also for their communication by a subtle fluid, if we admit Sir *Isaac Newton's* hypothesis concerning the cause of the alternate fits of easy reflection and transmission, as I have above remarked.

3. As sounds are caused by pulses or vibrations excited in the air by the tremors of the parts of
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ounding bodies, they must raise vibrations in the *membrana tympani*; and the small bones of the ear seem peculiarly adapted, by their situation and muscles, to communicate these vibrations to the cavities of the *vestibulum*, semicircular canals, and *cochlea*, in which the auditory nerve is expanded; *i. e.* to the nerve itself. Now though these are gross vibrations, in respect of those which we must suppose to take place in the æther itself, yet they prepare the way for the supposition of the more subtle vibrations of the æther, and may be the instrument of these, in the same manner as very gross reciprocal motions of bodies in the air are observed to produce, by percussion, those quicker vibrations in which sound consists.

4. We are, in some measure, prepared also for admitting the doctrine of vibrations in the animal functions, from that disposition to yield a sound upon percussion, which appears in some degree in almost all bodies; since this shews, that the disposition to vibrate is general, or even universal, in the bigger orders of particles; and therefore makes it more easy to conceive, that there may be a like disposition in the lesser orders, *i. e.* in the infinitesimal medullary particles, considered in this and the foregoing proposition.

5. The mutual attractions and repulsions which seem to intercede between all small particles, concur to the same purpose. For when the attractions and repulsions are changed, by changing the distances of the particles, these must oscillate to and fro for some time, before they can gain their former equilibrium.

6. Elasticity seems to result from mutual attractions and repulsions of some kind, and is evidently the cause of vibrations in musical strings, and many other bodies. It seems also, that there is scarce any body entirely devoid of elasticity. And thus elasticity

city is connected with the doctrine of vibrations in different ways.

7. The effluvia of electric bodies seem to have vibrating motions. For they are excited by friction, patting, and heat; and excite light, sound, and a pricking sensation. They have also a repulsive power in respect of each other, as the particles of air have; and therefore must, like them, be easily susceptible of vibrations. Their motions along hempen strings resemble the motions along the nerves in sensation and muscular contraction; and their attractive powers, at the end of such strings, resemble the powers of the sensations over the muscles for contracting them. So that electricity is also connected in various ways with the doctrine of vibrations.

Lastly, To sum up in one what has been remarked in the last five paragraphs: as the attractions of gravitation, electricity, magnetism, and cohesion, with the repulsions which attend upon the three last, intimate to us the general tenor of nature in this respect; viz. that many of its phænomena are carried on by attractions and repulsions; and that these may be expected to take place in the small descending orders of particles, as well as in gross bodies, and in the biggest component particles; so the pulses of the air, the tremors of sounding bodies, the propagation of sounds both through the air, and along contiguous solid bodies, the oscillations of elastic bodies, and the phænomena of electricity, may, in like manner, serve as a clue and guide to the invention, and afford a presumption, that other reciprocal motions or vibrations have a great share in the production of natural phænomena.

Nor is it an objection to this, but rather a confirmation of it, that these principles of attraction and repulsion of the several kinds, and of vibrations, are dependent upon, and involved within each other, since

Since this also is agreeable to the tenor of nature, as it is observed in the body, in the mind, in science in general, and in the several branches of each science in particular. Each part, faculty, principle, &c. when considered and pursued sufficiently, seems to extend itself into the boundaries of the others, and, as it were, to inclose and comprehend them all. Thus magnetism mixes itself with the gravitation both of bodies upon the surface of the earth, and with that of the moon to the earth: a polar virtue of the same kind seems to have a principal share in the formation of natural bodies, especially those whose parts cohere in regular figures: electricity may also extend, without being excited by friction or otherwise, to small distances, and join with the just mentioned polar virtue, in making the parts of bodies cohere, and, in some cases, in regular figures. The effervescence which attends the mixture of acids and alkalis, and the solution of certain bodies in menstruums, fermentation, and putrefaction, are all general principles of very extensive influence, nearly related to each other, and to the fore-mentioned mutual attractions and repulsions, and are possessed of the same unlimited power of propagating themselves, which belongs to the several specieses of plants and animals. A repulsion which should throw off indefinitely small corpuscles with indefinitely great velocity from all the bodies of the universe (a thing that would be very analogous to the emission of light, odoriferous particles, and magnetical and electrical effluvia, and to the generation of air and vapour), might cause the gravitation of all the great bodies of the universe to each other, and perhaps other kinds of attraction. Some of these corpuscles, by stopping each other in the intermundane spaces, or other mutually repulsive corpuscles lodged there from causes not yet discovered, may compose a subtle vibrating medium. The vibrations of this medium, being continued

continued to the great bodies of the universe, may so far agitate their small parts, as to give their attractive and repulsive powers an opportunity to exert themselves with great vigour; and the emission of the above-mentioned corpuscles may be, in part, occasioned by the attractions and consequent collisions of small parts thus agitated; so that elastic corpuscles may be thrown off from these small parts with indefinitely great velocity. And it would be no objection to these or such like suppositions, that we could not explain, in any definite manner, how these things are effected, nor put any limits to the sizes of decreasing corpuscles, or their active powers in respect of each other. Nor would this be to reason in a circle, more than when we argue, that the heart and brain, or the body and the mind, depend upon each other for their functions; which are undeniable truths, however unable we may be to give a full and ultimate explanation of them. However, it is not impossible, on the other hand, but future ages may analyse all the actions of bodies upon each other, up to a few simple principles, by making such suppositions as the phænomena shall suggest, and then trying and modelling them by the phænomena. At least this is what one is led to hope, from the many simple and easy solutions of very complex problems, which have been produced within the two last centuries.

We may draw the following corollaries from the hypothesis of vibrations, as laid down in the two foregoing *propositions*.

COROLLARY I. The vibrations of the medullary particles may be affected with four sorts of differences; viz. those of degree, kind, place, and line of direction. Vibrations differ in degree, according as they are more or less vigorous; *i. e.* as the particles oscillate to and fro, through a longer or shorter very short space; *i. e.* as the impression of the object is stronger or weaker, and thus affects the medullary particles

articles more or less vigorously, either directly and immediately, or mediately, by generating a greater or less degree of condensation in the pulses of the ether. Vibrations differ in kind, according as they are more or less frequent, *i. e.* more or less numerous, in the same space of time. They differ in place, according as they affect this or that region of the medullary substance of the brain primarily. And they differ in the line of direction, according as they enter by different external nerves.

COR. 2. The magnitude of each sensation is chiefly to be estimated from the vibrations which take place in the medullary substance of the brain, those which are excited in the spinal marrow and nerves being, for the most part, so inconsiderable, in respect of the just mentioned ones, that they may be neglected.

COR. 3. The brain may therefore, in a common way of speaking, be reckoned the seat of the sensitive soul, or the sensorium, in men, and all those animals where the medullary substance of the nerves and spinal marrow is much less than that of the brain; and this even upon the supposition laid down in the first proposition, viz. that the whole medullary substance of the brain, spinal marrow, and nerves, is the immediate instrument of sensation, and equally related to the sensitive soul, or principle. But if there be any reason to suppose, that the first proposition is not strictly true, but that the spinal marrow and nerves are only instruments subservient to the brain, just as the organs of the hand, eye, ear, &c. are to them, and the brain itself to the soul, we may conclude absolutely, that the sensorium of such animals is to be placed in the brain, or even in the innermost regions of it. Now there are some phænomena which favour this, by shewing, that whatever motions be excited in the nerves, no sensation can arise, unless this motion penetrate to, and prevail in, the brain. Thus, when a nerve is compressed, we lose the sense of

of feeling in the part to which it leads : a person much intent upon his own thoughts does not hear the sound of a clock ; *i. e.* the vibrations excited by this sound in the auditory nerve cannot penetrate to, and prevail in, the brain, on account of those which already occupy it : and a person who has lost a limb often feels a pain, which seems to proceed from the amputated limb ; probably because the region of the brain corresponding to that limb, is still affected.

If it be certain, that some of the medullary parts have been discharged, in abscesses of the brain, one would incline to think, that the external parts of the *medulla* are instrumental, in respect of the internal. And, on the other hand, one may question, whether, in animals of the serpentine form, and those whose brains are comparatively small, and in all those of the polypous kind, the sensorium be not equally diffused over the whole medullary substance, or even over all the living parts. I only hint these things, not presuming even to conjecture, but only to excite those who have proper opportunities, to inquire carefully into these matters.

COR. 4. If we allow the existence of the æther, and its use, in performing sensation, thought, and motion, as it may be inferred from the two foregoing propositions, compared with such other things as follow in these observations, in favour of the doctrine of vibrations ; we may conclude, that the æther must have a considerable share in the production of many other natural phænomena ; and therefore shall have a sufficient foundation for trying how far it will carry us, agreeably to the facts. I would recommend this, in a particular manner, to those persons who are much conversant with electrical phænomena ; especially as Sir *Isaac Newton* himself, whose great caution and reservedness, in difficult and doubtful matters, are sufficiently known, has made no scruple to affirm, that the powers of electrical bodies are owing to the
action

action of the æther. See the last paragraph of the Principia.

SCHOLIUM. It may be proper to remark here, that I do not, by thus ascribing the performance of sensation to vibrations excited in the medullary substance, in the least presume to assert, or intimate, that matter can be endued with the power of sensation. It is common to all systems, to suppose some motions attendant upon sensation, since corporeal objects must, by their actions, impress some motion upon our bodies, and particularly upon that part which is most nearly related to the sentient principle; *i. e.* upon the medullary substance, according to the first and second propositions. I lay down these propositions, therefore, as established by the common consent of physicians and philosophers; and upon that foundation proceed to inquire into, and determine, some matters of a more difficult nature; such as the complex problems concerning sensations, ideas, and motions, and their mutual influences and relations.

The following instance may illustrate this: the quantity of matter in bodies is always found to be proportional to their gravity: we may therefore either make the quantity of matter the exponent of the gravity, or the gravity the exponent of it, according as either can be best ascertained; notwithstanding that we are entirely at a loss to determine, in what mechanical way each atom contributes to the gravity of the whole mass; and even though we should, with some, suppose this effect to be immechanical, and to arise from the immediate agency of God. And, by parity of reason, if that species of motion which we term vibrations, can be shewn by probable arguments, to attend upon all sensations, ideas, and motions, and to be proportional to them, then we are at liberty either to make vibrations the exponent of sensations, ideas, and motions, or these the exponents of vibrations, as best suits the inquiry;

however impossible it may be to discover in what way vibrations cause, or are connected with sensations, or ideas; *i. e.* though vibrations be of a corporeal, sensations and ideas of a mental nature.

If we suppose an infinitesimal elementary body to be intermediate between the soul and gross body, which appears to be no improbable supposition, then the changes in our sensations, ideas, and motions, may correspond to the changes made in the medullary substance, only as far as these correspond to the changes made in the elementary body. And if these last changes have some other source besides the vibrations in the medullary substance, some peculiar original properties, for instance, of the elementary body, then vibrations will not be adequate exponents of sensations, ideas, and motions. Other suppositions to the same purpose might be made; and, upon the whole, I conjecture, that though the first and second propositions are true, in a very useful practical sense, yet they are not so in an ultimate and precise one.

P R O P. VI.

The Phenomena of sensible Pleasure and Pain appear to be very suitable to the Doctrine of Vibrations.

THE most vigorous of our sensations are termed sensible pleasures and pains, as noted above, in the introduction. And the vivid nature of these engages us to be very attentive to their several properties, relations, and oppositions. It is requisite therefore, in our inquiry into the doctrine of vibrations, to examine, how far the phenomena of sensible pleasure and pain can be deduced from, or explained by it.

First,

First then, The doctrine of vibrations seems to require, that each pain should differ from the corresponding and opposite pleasure, not in kind, but in degree only; *i. e.* that pain should be nothing more than pleasure itself, carried beyond a due limit. For of the four differences of vibrations mentioned in the first corollary of the foregoing proposition, three are given, viz. those of kind, place, and line of direction, in the pleasures and pains which correspond, as opposites to each other: there is therefore nothing left, from whence the difference of such pleasures and pains can arise, except the difference of degree. But the phænomena appear to be sufficiently suitable to this reasoning, inasmuch as all pleasure appears to pass into pain, by increasing its cause, impression, duration, sensibility of the organ upon which it is impressed, &c. Thus an agreeable warmth may be made to pass into a troublesome, or burning heat, by increase, or continuance; and the same thing holds, in respect of friction, light, and sounds. And as medicinal bodies appear, from observations both philosophical and vulgar, to be endued with more active properties than common aliments; *i. e.* to be fitted for exciting stronger vibrations; so their tastes and smells are, for the most part, ungrateful; whereas those of common aliments are pleasant. It may be observed also, that some painful sensations, as they decrease by time, or the removal of the cause, pass into positive local pleasures, of the same species as the preceding pain; thus shewing the near alliance between pleasure and pain; and that a mere difference in degree puts on the appearance of one in kind, at a certain point. I suppose it may be referred to this head, that some bitter and acrimonious tastes leave an agreeable relish of the sweet kind upon the tongue, after some time.

Secondly, It agrees well with the doctrine of vibrations, that all evident solutions of continuity in

the living parts occasion pain, inasmuch as a solution of continuity cannot happen without a violent impression of some sensible object, nor, by consequence, without violent mutual actions between the object, nerves, and æther. The solution of continuity does therefore presuppose that degree of violence in the vibrations, which exceeds the limit of pleasure, and is proper to pain, according to the foregoing paragraph.

Thirdly, We may, in like manner, give a reason, from the doctrine of vibrations, both why a moderate degree of distention in the parts is necessary to their growth, and pleasurable state; and also why all great distentions are attended with pain for a considerable time, before they are raised to such a pitch as to cause a visible solution of continuity. For a great distention is equivalent to a vigorous impression of a sensible object, being often caused by such; and as the situation of the small particles is changed in great distentions, their mutual actions will be changed also, and so may give rise to more vigorous vibrations; and these increased vibrations may either fall within the limits of pleasure, or go beyond them, according to their degree. We are also to consider, that, in all considerable distentions there is an increase of friction between the vessels and circulating fluids, and consequently of heat, *i. e.* of vibrations.

But besides this, it seems not improbable, that in preternatural and painful distentions, the small particles are perpetually separating themselves from their former cohesions, and running into new ones, so that a minute and invisible solution of continuity is carried on during the whole distention, till such time as this degree of distention becomes familiar to the parts, and the situation and mutual actions of the small particles be accommodated to it. Thus the cause of the pain in distentions will arise from the solution of continuity, and may be referred to the foregoing head.

And conversely it appears, that in manifest solutions

of continuity, occasioned by wounds, burns, &c. there always arises in the neighbouring parts, which are inflamed, a preternatural distention of the small fibres and vessels; by which means the pain is renewed and continued. Every manifest solution of continuity does therefore, according to the explanation of distention just laid down, include within itself an infinite number of minute invisible solutions.

Hence we may ask, whether this minute invisible solution of continuity in the infinitesimal medullary particles of the brain, is not that common limit, and middle point, which separates pleasure from pain, and of which the visible solutions of continuity, which are caused by external injuries, are a type, and also a means, viz. by propagating violent vibrations up to the brain. It is some presumption in favour of this position, that all conjectures concerning invisible things ought to be taken from visible ones of the same kind; also that it is particularly suitable to the doctrine of vibrations; inasmuch as, laying down this doctrine, one may easily conceive how moderate and pleasant impressions may agitate the medullary particles in so moderate a degree, as that they shall again return to their former situations and connections, when the agitation is over; whereas violent and painful ones may force the particles from thence, and give rise to new ones; *i. e.* to the solution of continuity. And as the body is so formed, that great and visible solutions of continuity may be healed again, and the parts restored, in great measure, to their primitive integrity and perfection, by the power of nature, unless where there is a loss of substance (and yet even here the same end is obtained in part); so we may suppose, that the power of nature restores all minute solutions of continuity in the constituent, infinitesimal particles, almost instantaneously, and so that the body receives no perceptible detriment from single instances, though it probably does from frequent repetitions;

titions; agreeably to which, it is generally supposed, that pain, by often returning, impairs the faculties, both bodily and mental.

Fourthly, The bones, nails, hair, and cuticle, may consistently with the doctrine of vibrations, have a solution of continuity produced in their parts, without pain ensuing; for they are hard, and therefore incapable, as it seems, of receiving and communicating to the contiguous nerves, and thence to the brain, vibrations of any considerable degree of strength. We are also to suppose, that in palsies, mortifications, &c. changes of texture of somewhat a like kind are produced, so as to render the parts affected thereby incapable of conveying sensation to the medullary substance of the brain. Old age, inactivity, inflammation, pain, &c. are in like manner to be considered, as inducing such a degree of condensation, fixation, and callosity, in the medullary substance itself, as must end at last in insensibility and death.

Fifthly, It is not unsuitable to the doctrine of vibrations, that the frequent repetition of the same external impressions should have the power of converting original pains into pleasures, and pleasures into mere sensations, *i. e.* into evanescent pleasures; as we find it has in fact. For this may be effected by such a change in the organ and brain, as that the organ shall send weaker and weaker vibrations perpetually to the brain, upon every successive renewal of the same impression, and the brain become perpetually less and less disposed to receive strong vibrations, though the power of communication from the impressions should continue the same. It remains therefore to be inquired, what general tendencies in the small medullary particles, might dispose them to undergo such changes. And it appears to me, that a change of the spheres of attraction and repulsion in these particles, upon every change in their situations, so as always to lean towards the situation last superinduced, might be sufficient

cient for this purpose. However, this is a mere supposition, and that of a very recluse nature. Only let it be observed, that the fact to be here accounted for, viz. the decrease in the efficacy of impressions frequently repeated, is both an evident one, and also must have its rise from some powers in the small parts of matter over each other. It must therefore admit of an explanation, either from the doctrine of vibrations, or from some other law of matter and motion. And if the doctrine of vibrations be found suitable to other phænomena, it may be presumed not to be unsuitable to this, till such time as some manifest inconsistency between them shall appear.

It ought to be remarked here, that this transit of original pains into pleasures, and of vivid pleasures into faint ones, by frequent repetition, bears some relation to the above-mentioned transition of pains into positive local pleasures; of the same kind with themselves.

To this head of consideration may be referred Dr. Jurin's observation, viz. "That when we have been
" for some time affected with one sensation, as soon
" as we cease to be so affected, a contrary sensation is
" apt to arise in us, sometimes of itself, and sometimes
" from such causes, as at another time would not produce that sensation at all, or, at least, not to the
" same degree." For the continued impression of the same object will so fix upon the sensory nerve, and region of the brain corresponding thereto, a tendency to one peculiar sort of vibrations, that an impression of an opposite, or very different sort, must do more than usual violence to the brain, *i. e.* will excite a glaring sensation of an opposite nature. See the Instances mentioned by Dr. Jurin, in his *Essay on distinct and indistinct Vision*.

Sixthly, We may account for the different kinds and degrees of pleasure and pain, from the four differences of vibrations mentioned above, viz. those

of degree, kind, place, and line of direction, and their various combinations with each other. For it is obvious to conceive, that these combinations may be sufficiently numerous and distinct from each other, to answer to the facts. If the vibrations go beyond the common limit of pleasure and pain in one part of the brain, at the same time that they fall short of it in others, the result will be a pleasure or pain, according as this or that sort of vibrations prevails; and if they be nearly equal, it will be difficult to determine of which kind it is. If the vibrations fall a little short in all the parts, they will generate a high degree of pleasure; which, however, must be less than the least general pain, *i. e.* such a one wherein the vibrations go beyond the limits in all the parts: but it may be far greater than partial pains, or than those which affect only one particular region of the brain. Hence we may see, that the pains are in general greater than the pleasures; but then they are more rare for the same reason, being such violent states as cannot arise from common impressions. Or, if we suppose the pains to be frequent, they will then so far alter the disposition of the medullary substance, according to what was said above, as that many original pains will be converted into pleasures: which indeed seems to be the case not unfrequently; for the organs of the new-born infant are so delicate, as to receive pain from many of those impressions which afterwards yield pleasure. But then, his sources of pleasure seem to be multiplied more than in proportion to what he suffers by this previous passage through pain.

In certain cases of excessive pains, the violent vibrations appear at last to excite a latent attractive power in the medullary particles, in the manner hereafter to be described, in respect of the fibres of the muscles and membranes, which puts a stop to those very vibrations that excited it. Hence faintings and stupors,

stupors, *i. e.* the cessation of pain from violent pains. However, a greater degree of vibrations is probably required for exciting this attractive power in the medullary particles than in white fibres, and in white fibres than in red ones, as will appear hereafter.

It follows also, from the principles here laid down, that all the pleasures, though particularly different from each other, ought to have a general resemblance, in their circumstances and consequences; and the pains likewise.

Seventhly, All the mere sensations, which enter the mind by the five external senses, admit of a general analysis, upon the same principles as the pleasures and pains do. For all the mere sensations were, in their original state, either pleasures or pains, and vary now from their original state only by the diminution of the degree. Let therefore all the differences of kind, place, and line of direction, be combined in all their varieties, the degree being supposed every where evanescent; and we shall have all the particular vibrations from whence each mere sensation arises. This is the general account. But it is a most difficult problem to explain, by what differences of kind the particular sensations, either of the same, or of different senses, are distinguished from each other.

It seems probable to me, that the limits of the seven primary colours, *viz.* the extreme red, the limit of the red and orange, of the orange and yellow, yellow and green, green and blue, blue and indigo, indigo and violet, and the extreme violet, excite vibrations in the optic nerve, whose times are proportional to the times of vibration of a string which sounds the notes in order, according to the key mentioned by Sir *Isaac Newton* in his *Optics*, *i. e.* the notes D, E, F, G, A, B, C, D. This hypothesis affords at least a probable reason for the several very particular breadths of the primary colours,

lours, in the prismatic oblong image of the sun, as I shall endeavour to shew in its place, *Prop. 56.*

If the frequency of the vibrations excited by the several sapid and odorous bodies in the nerves of the tongue and membrana schneideriana, could be discovered, it is not improbable but this would be a clue to lead us into the inner constitution of natural bodies, since one may reasonably suppose, that each sapid and odorous body excites vibrations of the same frequency as those which take place in it before it is tasted or smelt to.

The solution of the same problem, in the several senses, might also a little unfold to us the different internal structure of the several nerves, and of the parts of the brain that correspond thereto. For it seems probable to me, that each nerve and region is originally fitted to receive, and, as one may say, sympathize with, such vibrations as are likely to be impressed upon them in the various incidents of life; and not that the auditory nerve could perform the office of the optic, if put into its place, or *vice versa*, &c. according to *Raw.*

Eighthly, It is observed by medical writers, that pain is apt to excite a contraction in the fibres of the neighbouring membranes. Now this is very agreeable to that power which sensory vibrations have, in general, over the red fleshy muscles, for contracting them, in the manner to be described hereafter. For since vibrations of a middle strength, by descending into the red fibres of the muscles, are sufficient to contract them in the ordinary functions and actions of life, it is not unreasonable to expect, that the stronger vibrations, which attend pain, should be sufficient to contract the pale fibres of membranes, though these be in themselves of a less contractile disposition.

It is agreeable to this, that titillation and itching, which lie, as it were, upon the confines of pleasure and pain, are more apt to diffuse themselves over the neighbouring

neighbouring parts than pain. For titillation and itching only agitate the small particles of the membranes, and therefore run along their surfaces, by the successive communication of these agitations; whereas pain, by contracting the fibres, puts a stop to these agitations, and consequently to its own diffusion over the neighbouring parts.

Ninthly, Extreme and pointed parts, such as the extremity of the nose, the uvula, the epiglottis, the nipples, and the ends of the fingers, are in general more subject to irritation, itching, and inflammation, and endued with a greater degree of sensibility than the other parts. Now this phænomenon agrees with the doctrine of vibrations, inasmuch as such parts must, according to the *Newtonian* hypothesis, be surrounded with an æther of a greater density than that within their pores, and which also grows denser and denser, in a regular manner. For one may conceive, that the vibrations communicated to this denser æther, will be stronger in proportion to its density; and consequently, that they will agitate the small particles of the extreme parts also with vibrations stronger than ordinary.

It is true, indeed, that the sensibility of each part does depend, in great measure, on the number, structure, and disposition of the nervous papillæ, which are the immediate organ in the senses of feeling, taste, and smell; but then we may remark, that the same observation holds in respect of these nervous papillæ. For they are also extreme and pointed parts, and that especially, if we suppose, which seems probable, that when any part is in a state of exquisite sensibility, the nervous papillæ are erected (in some such manner as the hairs of the neck and back in certain animals, when enraged), so as to recede from each other, and consequently, to admit the denser æther between them. They may also, upon the same occasions, be made turgid, by the constriction of
their

their bases, and thus have their sensibility, or power of receiving vibrations, increased by distention.

We may remark likewise, in pursuing this method of reasoning, that the æther which lies contiguous to the medullary substance in the ventricles of the brain, is denser than that which lies in the medullary substance itself. May we not therefore conjecture, that one use of the cavities of the ventricles is to increase and keep up all the vibrations propagated from the external nerves into the medullary substance of the brain, by means of the denser æther lodged in those cavities; that blood and serum extravasated, and lying in the ventricles, suffocate sensations, by excluding this denser æther, as well as by pressing on the medullary substance; and, lastly, that those brutes whose olfactory nerves have cavities within them continued from the ventricles, are more acute than men, in perceiving odours, and distinguishing them from each other, in part, upon this account? *Boerhaave* is, indeed, of opinion, that the opposite sides of the ventricle always touch each other, so as to leave no cavity. But it seems more reasonable to suppose, that a subtle vapour, which is exhaled from the vessels of the investing membrane, and whose particles, like the vapour of water, have a repulsive power, in respect of each other, prevents the absolute mutual contact of the opposite sides, in common cases. And the same thing is favoured by the experiments tried upon the *Parisian* beggar. Since the brain in him could be somewhat pressed in, it seems that the skull was not entirely full before.

P R O P. VII.

The Phenomena of Sleep appear to be very suitable to the Doctrine of Vibrations.

HERE I observe, first, that new-born children sleep almost always. Now this may be accounted for by the doctrine of vibrations, in the following manner: the foetus sleeps always, having no sensation from without impressed upon it, and only becomes awake upon its entrance into a new world, viz. by means of the vigorous vibrations which are impressed upon it. It is reasonable therefore to expect, that the new-born child should fall back into its natural state of sleep, as soon as these vibrations cease, and return again to a state of vigilance, only from the renewal of vigorous impressions; and so on alternately, agreeably to the fact.

Secondly, Even adults are disposed to sleep, when the impressions of external objects are excluded; and their bodies kept in a state of rest, for the same reasons as those just mentioned in the similar state of young children. However, they incline more to vigilance than children, partly because their solids and fluids are more active, and less compressible, *i. e.* more susceptible and retentive of vibrations; and partly, because association brings in perpetual trains of ideas, and consequently of vibrations, sufficiently vivid to keep up vigilance in common cases.

Thirdly, Having presented the reader with the two foregoing observations, which are of a very obvious kind, I will now inquire with more minuteness, into the intimate and precise nature of sleep. It appears then, that, during sleep, the blood is accumulated in the veins, and particularly in the venal sinuses which surround the brain and spinal marrow; and also, that it is rarefied, at least for the most part.

For

For as the actions of the muscles squeeze the blood out of the veins during vigilance, so their inactivity during sleep suffers the blood to lodge in the veins; and the decumbent posture, which is common to animals in sleep, suffers it to lodge particularly in the venal sinuses of the brain and spinal marrow. And it is agreeable to this, that, in most dissections, the blood is found chiefly in the veins, and, in dissections after lethargies, apoplexies, &c. the venal sinuses of the brain, and consequently those of the spinal marrow, which communicate freely with them, are particularly full. As to the rarefaction of the blood, it follows from the warmth of the body, which is an usual attendant upon sleep, and is caused by the rest of the body, the warmth of the place where the person sleeps, the coverings, and the fermentative disposition of the fresh chyle, which then enters the blood. It follows therefore, that the brain and spinal marrow will be particularly compressed during sleep, since the blood then takes up more space, is particularly accumulated within the cavities of the skull and vertebræ, and the hardness of these bones will not suffer them to yield or make more room. It follows also, that the softness of the medullary substance will subject it to the effects of this compression, more than the cortical; so that, if we suppose its functions to consist in receiving, retaining, and communicating vibrations, it will be rendered peculiarly unfit for these functions, from the compression here mentioned, *i. e.* the animal will be indisposed to sensation and motion, agreeably to observation.

There are many other arguments which might be brought to shew, that during sleep, and sleepy distempers, the brain is particularly compressed, if it were necessary. But the instance of the *Parisian* beggar, above noted, is most to this purpose. This person had a perforation in his skull, which did not ossify;

ossify; whence, by external pressure upon that part, the internal regions of the brain might be affected; and it was constantly observed, that, as the pressure increased, he grew more and more sleepy, and at last fell into a temporary apoplexy.

In young children, there seems to be a constant moderate pressure of the skull upon the brain. For the brain is of a great relative magnitude in them, and, by its endeavour to expand itself, it keeps the sutures from uniting too firmly, till such time as it is arrived at its full growth. It must therefore be compressed in return, by the re-action of the skull. And this may be considered as a circumstance, which concurs to render young children more apt to sleep than adults. When old persons are sleepy, it is a morbid affection, and may arise either from an hydropical disposition, whereby the turgescence of the neighbouring parts compresses the medullary substance; or from a defect of nutrition in this substance, which renders it soft and compressible in a preternatural degree. If the venal sinuses, and other blood vessels, of the brain, be, by any accident preternaturally distended, and continue so for a considerable time, they will scarce ever recover their pristine tone and dimensions; and this so much the more, as the person approaches to old age.

For the same reason, as the medullary substance within the skull and vertebræ is compressed during sleep, that of the ganglions, plexuses, and trunks of the nerves in other parts of the body, will be compressed also, though in a less degree. For this substance has no blood or gross fluids within it, and is far the softest of all the parts of the body; and the membranes, which invest all the parts of the body, perform the same office to them, in a less degree, as the skull does to the brain, *i. e.* check their distention. The surrounding membranes must therefore compress the soft medullary substance in the ganglions,

glions, plexuses, and trunks of the nerves, during sleep, on account of the rarefaction of the humours at that time; whence, according to the doctrine of vibrations, sensory ones can neither ascend freely from the external organs to the brain, nor motory ones descend into the limbs, *i. e.* the animal will be insensible and inactive, as it is found to be in fact.

Is it not probable, that, as sleep comes on, the opposite sides of the ventricles of the brain approach towards each other, on account of the compression here asserted; also, that they become contiguous at the instant of sleep, excluding the denser æther, mentioned in the foregoing proposition, thereby? By this means, the power of sensation would receive a remarkable diminution at the instant of falling asleep, as it seems to do. There might also, in certain circumstances, arise a very vivid exertion of the perceptive and motive faculties at that instant, from the compression of the æther previous to its rarefaction, such as would account for the sudden terrors and startings which happen at the instant of going to sleep, in some morbid cases.

Fourthly, It is observed, that vigilance continued, fatigue, and pain, all dispose strongly to sleep. For all vigorous or long-continued vibrations must both generate heat, whereby the blood and juices will be rarefied, so as to compress the medullary substance, and also exhaust this substance of its fluid and active particles, so as to render it more easily compressible, and less susceptible and retentive of vibrations. Great degrees of heat seem to produce an extraordinary propensity to sleep, in nearly the same way.

And when persons exposed to extreme cold are overcome by a pleasing, but fatal sleep, it seems as if the internal parts were affected with a preternatural warmth, from the vigorous sensations and concomitant vibrations impressed on the external parts by the cold, and thence ascending to the brain. It agrees

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with the hypothesis here proposed, that these uneasy sensations decline by degrees, till they fall within the limits of pleasure, and, at last, end in insensibility. This sleep may prove fatal, from the great difference between the internal and external parts, in respect of heat; also from the cold's penetrating farther and farther. Muscular motion may prevent it, and its ill effects, partly as the veins are emptied by this, partly as it warms the external parts, and cools the internal, from the return of the cool blood into the course of the circulation. If we suppose the circulation to cease entirely, at the surface of the body from the cold, then will warm blood circulate through the internal parts alone; and these parts will continue to be defended from the cold by the external ones, for a time. And thus the body will approach to the common state of a person going to sleep.

It is easy to see, from the method of reasoning here used, how persons recovering from long illnesses should be much disposed to sleep, viz. from the exhaustion of the medullary substance, their almost constant rest, their being kept warm, and the frequent taking sustenance, so as to beget great quantities of fresh chyle, and consequently, an extraordinary degree of a fermentative heat.

Fifthly, The manner in which opiates produce sleep may be thus explained, agreeably to the doctrine of vibrations. Opiates evidently excite grateful sensations in the stomach and bowels. This appears from the short time in which liquid opiates take effect; and even from immediate and direct sensations: a person may even feel, that the stomach is the seat of the pleasurable impressions made by opiates. We are to suppose therefore, that vivid vibrations, which, however, lie within the limits of pleasure, ascend perpetually from the stomach and bowels along the par vagum, and intercostal nerves, up to the brain and spinal marrow, diffuse themselves

over these, and from thence descend along the nerves into all the parts of the body. Hence it follows, that they will obscure and over-power all moderate sensations, or vibrations, which subsisted before, or which external objects may from time to time endeavour to excite, and introduce a general pleasurable state over the whole nervous system; with trains of pleasurable ideas, in the manner to be explained hereafter, when we come to treat of ideas, their generations, associations, and dependencies on bodily states. During this pleasurable state, the body will of course be composed to rest; restlessness, tossings, and changes of posture, being caused, for the most part, by uneasy sensations. Hence the blood will be accumulated in the veins and venal sinuses, and grow warm both from the vigorous vibrations excited by the opiate, and from the absolute rest of the body. For absolute rest conduces, in a peculiar manner, to make the body grow warm, by the heat reflected from the contiguous coverings; as, on the contrary, the slightest motions frequently returning, ventilate and cool the parts. And thus the compression of the medullary substance requisite for sleep, will be induced by the action of the opiate upon the stomach and bowels.

But, besides this, we may conceive, that the opiate particles excite vibrations of the same kind in all the parts of the body, after they are taken into the blood, and circulate with it, till such time as, by a perfect assimilation, they lose all their peculiar qualities.

It seems also, that the continued descent of vibrations, from the brain, and spinal marrow, into the limbs, and external parts, agitate them so much, as to render them unfit for receiving sensation and motion, in the same manner as continued friction of the head, when newly shaved, or shaking the hand, occasion a kind of numbness in the head and hand respectively. For a disorder raised in the motory nerves,
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and muscular fibres, analogous to numbness in the sensory nerves, and sentient papillæ, must produce ineptitude to motion. It seems therefore, that the insensibility and immobility which proceed from opiates, and which concur in hastening the sleep, and increasing its degree, arise in great part from this cause. The numbness, and paralytic weaknesses, which frequently succeed after opiates, are evidences for what is here alleged.

Opium seems to have an intermediate degree of activity between narcotics, or stupefying poisons, on one hand, and grateful aliments, particularly vinous liquors, on the other. Narcotics operate so violently on the stomach and bowels, the brain, and the external parts, as to bring confusion on the sensations, and trains of ideas, and convulsions on the muscular system. And that these effects are produced by a local influence on the stomach, in the manner proposed concerning opiates, appears, because they cease, or abate much, soon after the narcotic is ejected by vomiting; also because whipping a dog, after he has taken the *nux vomica*, contributes to obviate its ill effects. Wines, and grateful aliments, dispose to sleep, partly by their immediate effects on the stomach, partly by their effects after they are absorbed. But the degree not being so great as in opiates, it may more easily be overcome by a variety of common or vigorous impressions; in which case the vivid vibrations excited by the wine, or aliment, will illuminate all the impressions, and add strength to all the motions. The same thing is observed of opiates, in those who take them frequently.

Sixthly, Chylification, sanguification, nutrition, and growth, seem to proceed best during sleep. This may be conjectured from the sleepiness of all animals after eating, since sleep and chylification, &c. must here concur; and from the almost constant sleep of

new-born children, above taken notice of, since nature seems chiefly intent on the due performance of these functions, for some time after birth. Now the doctrine of vibrations may be made to illustrate these points, in some measure. For since respiration becomes strong and convulsive at the instant of going to sleep, it will renew and increase the vibrations excited in the nerves of the stomach and bowels by their contents, which we must suppose to have languished before, in the same manner as those which subsisted in the external senses. The organs of digestion therefore, as well as those of respiration, are in a state of vigilance, and are intent upon the performance of their proper functions, while the other parts are in a state of sleep and inaction, and recruiting, in order to perform their functions in a due manner, upon a return of vigilance. And this holds most particularly in respect of the medullary substance of the brain, spinal marrow, and nerves, which, by the consent of all, is the chief instrument of nutrition and growth. Since the vibrations which take place in it during sleep are languid, it will then be filled and recruited, and consequently fitted for nutrition and growth; which will be farther favoured by the concurrence of a complete chylification and sanguification, at the same time.

The increased convulsive respiration, and increased force of the heart, which take place at the instant of going to sleep, and continue frequently during sleep, may perhaps be thus accounted for, agreeably to the doctrine of vibrations. When vivid vibrations cease in the external senses, and regions of the brain belonging to them, also in the muscles of the limbs, and parts of the spinal marrow corresponding thereto, this abatement of vibrations must either extend to the whole medullary substance, which seems to be the case in the night-mare; or if the nerves of the heart,* and organs of respiration, and the regions of
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the brain and spinal marrow corresponding thereto, be exempted, they may be agitated even with more vigorous vibrations, on account of the abatement in the other parts, because the vibrations raised in these regions during sleep, by such of their causes as take place then, will be hindered from diffusing themselves freely, and abating their own force thereby, as soon as the other regions are collapsed and compressed. These causes are, first, the heat of the blood, and pulsation of the arteries of the medullary substance; both which, when increased on any account, must farther increase themselves by a reflected influence, since both increase the force of the heart. Secondly, the fulness and distention of the lungs. These arise from the rarefaction of the blood, and accumulation of it in the veins just before sleep (at which time respiration is languid), and must at last stimulate the organs of respiration to a vigorous exertion of themselves, *i. e.* raise vigorous vibrations in the region of the brain corresponding thereto, just as in the cases of sighing, and recovering from the night-mare. Thirdly, we may suppose, that the heart, and muscles of respiration, do not exert themselves during vigilance, with a degree of force at all approaching to their utmost powers, as the limbs do; and therefore, that they, and the corresponding regions of the brain, may be qualified for a vigorous exertion during sleep. Fourthly, an increase in the force of respiration must also increase the force with which the heart moves, because it propels the blood in greater quantities upon the heart. Fifthly, an increase of force in the heart must increase both itself, and the action of respiration, because the blood vessels of the heart and organs of respiration are particularly near to the heart, and therefore must be particularly under its influence.

COROLLARY I. By laying together what has been delivered concerning sleep, in this proposition, the

difference between the states of sleep and vigilance may be thus set before the reader, in one view. In sleep, the nerves of the five external senses are indisposed to receive vibrations, and the objects themselves are either absent, or impressed feebly. The nerves of the stomach and bowels sympathize with these at first, but recover themselves at the instant of sleep, the impressions of the aliment, &c. being then made with unusual vigour; and this continues during the time of sleep. In like manner the muscular system becomes inactive in general; the heart, however, and muscles of respiration, are excepted, and even exert themselves with an extraordinary degree of force. The blood is rarefied so as to take up more space upon the whole; and as there is more in the veins, and particularly in those of the brain, and spinal marrow, than in a state of vigilance, the medullary substance is hereby exposed to a constant uniform compression; whereas, in vigilance, the action of the muscles squeezes the blood out of the veins, and cools it, unless this action be violent, or long continued. The glands are filled during sleep, and consequently, by drawing off from the fulness of the blood vessels, prepare the body for vigilance, and are themselves fitted for the functions to be then performed, *i. e.* to excrete their proper fluids from muscular compression, or vibrations running up their excretory ducts, in the manner to be hereafter explained. The medullary substance is, in like manner, fitted and prepared for vigilance, whether it be of a glandular nature, or not. However, some vibrations must take place in it throughout, and they are particularly vivid in the regions corresponding to the heart, organs of respiration, and organs of digestion; also in the regions corresponding to the eye and ear, where they excite the trains of images which are presented to us in our dreams. But the nature of these cannot be unfolded till we have treated of ideas, their generation and associations,

affociations, and the nature of true and erroneous judgments, assent, dissent, imagination and memory.

COR. 2. It appears also to follow, from the foregoing account of sleep, and the effect of heat, labour, pain, and opiates, in disposing to it, that, in many cases of sleep, the medullary substance tends to a subtle kind of inflammation, and is preserved from it, and restored to its natural state, and degree of heat, by means of sleep sufficiently continued. Thus, in the access of most fevers, the patient is listless and sleepy, the external senses, muscles, and brain, being affected, in some respects, as by opiates. If the patient sleeps, the distemper is cut short; but if the subtle inflammation be so great as to prevent that, the distemper increases, and comes to its period in some other way, according to the nature of the fever, and circumstances of the patient. In a *coma vigil* it seems to me, that the approach of the opposite sides of the ventricles excites such violent vibrations, on account of the inflammation of the medullary substance, perhaps of these sides particularly, as to awake the patient, and throw him into great confusion and consternation. In a frenzy, the medullary substance itself seems to labour under an acute temporary inflammation, the other parts having often no more than a due heat, whereas, in the delirium of a fever, the medullary substance only sympathizes with the other parts. If the inflammation of the medullary substance be very subtle, moderate, and permanent, madness of some species ensues. And it seems to agree very well with the theory here proposed, that in deliriums, frenzies, and some kinds of madness, the patient does not sleep at all, or, if he does, in a quiet manner, is freed from his distemper; and that, in other kinds of madness, and in cases of melancholy, the sleep is very deep, and the patient extremely sluggish.

S E C T. II.

OF IDEAS, THEIR GENERATION AND ASSOCIATIONS ; AND OF THE AGREEMENT OF THE DOCTRINE OF VIBRATIONS WITH THE PHÆNOMENA OF IDEAS.

P R O P. VIII.

Sensations, by being often repeated, leave certain Vestiges, Types, or Images, of themselves, which may be called, Simple Ideas of Sensation.

I TOOK notice in the introduction, that those ideas which resemble sensations were called ideas of sensation ; and also that they might be called *simple* ideas, in respect of the intellectual ones which are formed from them, and of whose very essence it is to be *complex*. But the ideas of sensation are not entirely simple, since they must consist of parts both co-existent and successive, as the generating sensations themselves do.

Now, that the simple ideas of sensation are thus generated, agreeably to the proposition, appears, because the most vivid of these ideas are those where the corresponding sensations are most vigorously impressed, or most frequently renewed ; whereas, if the sensation be faint, or uncommon, the generated idea is also faint in proportion, and, in extreme cases, evanescent and imperceptible. The exact observance of the order of place in visible ideas, and of the order of time in audible ones, may likewise serve to shew, that these ideas are copies and offsprings of the impressions made on the eye and ear, in which
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the same orders were observed respectively. And though it happens, that trains of visible and audible ideas are presented in sallies of the fancy, and in dreams, in which the order of time and place is different from that of any former impressions, yet the small component parts of these trains are copies of former impressions; and reasons may be given for the varieties of their compositions.

It is also to be observed, that this proposition bears a great resemblance to the third; and that, by this resemblance, they somewhat confirm and illustrate one another. According to the third proposition, sensations remain for a short time after the impression is removed; and these remaining sensations grow feebler and feebler, till they vanish. They are therefore, in some part of their declension, of about the same strength with ideas, and, in their first state, are intermediate between sensations and ideas. And it seems reasonable to expect, that, if a single sensation can leave a perceptible effect, trace, or vestige, for a short time, a sufficient repetition of a sensation may leave a perceptible effect of the same kind, but of a more permanent nature, *i. e.* an idea, which shall recur occasionally, at long distances of time, from the impression of the corresponding sensation, and *vice versâ*. As to the occasions and causes, which make ideas recur, they will be considered in the next proposition but one.

The method of reasoning used in the last paragraph, is farther confirmed by the following circumstance; viz. that both the diminutive declining sensations, which remain for a short space after the impressions of the objects cease, and the ideas, which are the copies of such impressions, are far more distinct and vivid, in respect of visible and audible impressions, than of any others. To which it may be added, that, after travelling, hearing musick, &c. trains of vivid ideas are very apt to recur, which correspond

respond very exactly to the late impressions, and which are of an intermediate nature between the remaining sensations of the third proposition, in their greatest vigour, and the ideas mentioned in this.

The sensations of feeling, taste, and smell, can scarce be said to leave ideas, unless very indistinct and obscure ones. However, as analogy leads one to suppose, that these sensations may leave traces of the same kind, though not in the same degree, as those of sight and hearing; so the readiness with which we reconnoiter sensations of feeling, taste, and smell, that have been often impressed, is an evidence, that they do so; and these generated traces or dispositions of mind may be called the ideas of feeling, taste, and smell. In sleep, when all our ideas are magnified, those of feeling, taste, and smell, are often sufficiently vivid and distinct; and the same thing happens in some few cases of vigilance.

P R O P. IX.

Sensory Vibrations, by being often repeated, beget, in the medullary Substance of the Brain, a Disposition to diminutive Vibrations, which may also be called Vibratiuncles and Miniatures, corresponding to themselves respectively.

THIS correspondence of the diminutive vibrations to the original sensory ones, consists in this, that they agree in kind, place, and line of direction; and differ only in being more feeble, *i. e.* in degree.

This proposition follows from the foregoing. For since sensations, by being often repeated, beget ideas, it cannot but be that those vibrations, which accompany sensations, should beget something which may accompany ideas in like manner; and this can be nothing but feebler vibrations, agreeing with the sensory
generating

generating vibrations in kind, place, and line of direction.

Or thus: By the first proposition it appears, that some motion must be excited in the medullary substance, during each sensation; by the fourth, this motion is determined to be a vibratory one: since therefore some motion must also, by the second, be excited in the medullary substance during the presence of each idea, this motion cannot be any other than a vibratory one: else how should it proceed from the original vibration attending the sensation, in the same manner as the idea does from the sensation itself? It must also agree in kind, place, and line of direction, with the generating vibration. A vibratory motion, which recurs t times in a second, cannot beget a diminutive one that recurs $\frac{1}{2}t$, or $2t$ times; nor one originally impressed on the region of the brain corresponding to the auditory nerves, beget diminutive vibrations in the region corresponding to the optic nerves; and so of the rest. The line of direction must likewise be the same in the original and derivative vibrations. It remains therefore, that each simple idea of sensation be attended by diminutive vibrations of the same kind, place, and line of direction, with the original vibrations attending the sensation itself: or, in the words of the proposition, that sensory vibrations, by being frequently repeated, beget a disposition to diminutive vibrations corresponding to themselves respectively. We may add, that the vibratory nature of the motion which attends ideas, may be inferred from the continuance of some ideas, visible ones for instance, in the fancy for a few moments.

This proof of the present proposition from the foregoing, appears to be incontestable, admitting the fourth: however, it will much establish and illustrate the doctrines of vibrations and association, to deduce it directly, if we can, from the nature of vibratory

bratory motions, and of an animal body; and not only from the relation between sensations and ideas. Let us see, therefore, what progress we can make in such an attempt.

First then, If we admit vibrations of the medullary particles at all, we must conceive, that some take place in the *fœtus in utero*, both on account of the warmth in which it lies, and of the pulsation of those considerable arteries, which pass through the medullary substance, and which consequently must compress and agitate it upon every contraction of the heart. And these vibrations are probably either uniform in kind and degree, if we consider short spaces of time; or, if long ones, increase in a slow uniform manner, and that in degree only, as the *fœtus in utero* increases in bulk and strength. They are also probably the same in all the different regions of the medullary substance. Let these vibrations be called the *natural vibrations*.

Secondly, As soon as the child is born, external objects act upon it violently, and excite vibrations in the medullary substance, which differ from the natural ones, and from each other, in degree, kind, place, and line of direction. We may also conceive, that each region of the medullary substance has such a texture as to receive, with the greatest facility, the several specific vibrations, which the objects corresponding respectively to these regions, *i. e.* to their nerves, are most disposed to excite. Let these vibrations be, for the present, called *preternatural ones*, in contradistinction to those which we just now called *natural ones*.

Thirdly, Representing now the natural vibrations by *N*, and the preternatural ones, from various objects, by *A, B, C, &c.* let us suppose the first object to impress the vibrations *A*, and then to be removed. It is evident from the nature of vibratory motions, that the medullary substance will not, immediately upon

upon the removal of this object, return to its natural state N , but will remain, for a short space of time, in the preternatural state A , and pass gradually from A to N . Suppose the same object to be impressed again and again, for a sufficient number of times, and it seems to follow, that the medullary substance will be longer in passing from A to N , after the second impression, than after the first, after the third impression than second, &c. till, at last, it will not return to its natural original state of vibrations N at all, but remain in the preternatural state A , after the vibrations have fallen to a diminutive pitch, their kind and place, or chief seat, and their line of direction, continuing the same. This state may therefore be fitly denoted by a , and being now in the place of the natural state N , it will be kept up by the heat of the medullary substance, and the pulsation of its arteries. All this seems to follow from the above-mentioned disposition of animal bodies to accommodate themselves to, and continue in, almost any state that is often impressed; which is evident from innumerable both common and medical observations, whatever be determined concerning the manner of explaining and accounting for these facts. For the alterations which habit, custom, frequent impression, &c. make in the small constituent particles, can scarce be any thing besides alterations of the distances, and mutual actions, of these particles; and these last alterations must alter the natural tendency to vibrate. We must, however, here resume the supposition made in the last paragraph, viz. that the several regions of the brain have such a texture as disposes them to those specific vibrations, which are to be impressed by the proper objects in the events of life. And this will much facilitate and accelerate the transition of the state N into a ; since we are to suppose a predisposition to the state A , or a .

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It will somewhat illustrate and confirm this reasoning, to remark, that musical strings always accommodate themselves to, and lean towards, the state into which they were last put. Thus the tone of a musical string either rises or falls upon altering its tension, according as the preceding tension was greater or less than its present tension. Now the small component parts of a musical string must recede from, and approach to each other, *i. e.* must oscillate lengthways, during every transverse oscillation of the string. And this must arise from the mutual influences of the component particles tending to their last superinduced state. Let us suppose something analogous to this to take place in the component molecules of the brain, the molecules of the molecules, &c. and it will follow, that *A* may over-power *N*, and *a* become the natural state. Now, since the human body is composed of the same matter as the external world, it is reasonable to expect, that its component particles should be subjected to the same subtle laws. And the exquisite structure of animal bodies in so many other respects, makes it easier to conceive, that the organ of organs, viz. the medullary substance should be endued with a proper subtle ultimate structure, for the purpose of retaining a state that is frequently impressed. One may guess also, that it is better suited to this purpose during its growth, *i. e.* in passing from infancy to adult age, than afterwards; as this would be very agreeable to the phænomena.

Fourthly, Suppose now the vibrations *A*, *B*, *C*, *D*, &c. belonging to each of the senses, to be excited, and repeated in such order and manner as usually happens to the new-born infant upon its entrance into this new scene of things. It is evident, that these will have a greater power to over-rule the natural state *N*, than the vibrations *A* from one single object could have: for *A* affected only one region of the medullary substance primarily; whereas *A*, *B*, *C*, *D*, &c.

&c. affect all the regions primarily in their turn. It is evident also, that the secondary vibrations, or those which are propagated from the region of the medullary substance primarily affected into the rest, will be over-ruled, in great measure, in each region, by the primary vibrations peculiar to that region. Lastly, It is evident, that of the vibrations which are excited in each region, no one can prevail over all the rest, but each must leave an effect, in proportion to its strength and frequency. We may conceive therefore, that each region of the medullary substance will have a tendency generated in it, to vibrate with vibrations of the same frequency (but weaker in degree) as those which the several appropriated objects impress upon it respectively; and that diminutive vibrations resembling them will rise in succession in each region. For each region may easily be conceived to lean sometimes to the vibrations from one object, sometimes to those from another, according to the strength, frequency, and novelty of the impression, the then present disposition of the nervous system, association (of which in the two next propositions), and other such-like causes. And for the same reason, as in every sense the idea of some one object of that sense must prevail over all the rest, we may conclude, that sometimes the ideas belonging to one sense, sometimes those belonging to another, will prevail over the rest.

Or thus: Some vibrations there must always be in the medullary substance, on account of its heat, and the pulsation of the arteries which pass through it. These cannot be the natural ones *N*, because they will soon be over-ruled by the great force and variety of the impressions made on the new-born infant, which must also dispose each region of the brain to lean to some or other of those vibrations which are excited in it primarily. Hence we may conceive, that a very complex set of vibrations, arising from the mixture and combinations of degree, kind, place, and line of direction,

direction, exists always in the medullary substance, being kept up by its heat, and the pulsation of its arteries, when other causes are wanting, almost in the same manner as in a concert of music the air is agitated by vibrations of a very complex kind. But then, as in a concert, some one instrument generally strikes the ear more than the rest, so of the complex vibrations which exist in the medullary substance, some one part will prevail over the rest, and present the corresponding idea to the mind. Some region must be disposed, at each instant, to vibrate stronger than the rest; and of the specific vibrations which are generally impressed upon this region, some one will have a more favourable concurrence of circumstances than the rest. And thus it will follow, according to the terms of the proposition, that sensory vibrations, by being sufficiently repeated, will beget a disposition to miniature vibrations corresponding to them respectively; or, using the appellations above-assumed, that *A, B, C, &c.* will beget *a, b, c, &c.*

If we allow the proof of this proposition, thus deduced from the nature of vibratory motions, and of an animal body, the foregoing proposition will follow from it, and hold equally, in respect of the senses of feeling, taste, and smell, as of sight and hearing. Or, in other words, if we allow, that original impressed vibratory motions leave a tendency to miniature ones of the same kind, place, and line of direction, it will follow, that sensations must beget ideas, and that not only in the senses of sight and hearing, where the ideas are sufficiently vivid and distinct, but in the three others, since their sensations are also conveyed to the mind by means of vibratory motions. We may also, perhaps, discover hereafter, from the nature of vibratory motions, and of the human brain, compared with the circumstances of life, why the ideas of one sense are more vivid and distinct than those of another.

P R O P. X.

Any Sensations A, B, C, &c. by being associated with one another a sufficient Number of Times, get such a Power over the corresponding Ideas a, b, c, &c. that any one of the Sensations A, when impressed alone, shall be able to excite in the Mind b, c, &c. the Ideas of the Rest.

SENSATIONS may be said to be associated together, when their impressions are either made precisely at the same instant of time, or in the contiguous successive instants. We may therefore distinguish association into two sorts, the synchronous, and the successive.

The influence of association over our ideas, opinions and affections, is so great and obvious, as scarce to have escaped the notice of any writer who has treated of these, though the word *association*, in the particular sense here affixed to it, was first brought into use by Mr. *Locke*. But all that has been delivered by the ancients and moderns, concerning the power of habit, custom, example, education, authority, party-prejudice, the manner of learning the manual and liberal arts, &c. goes upon this doctrine as its foundation, and may be considered as the detail of it, in various circumstances. I here begin with the simplest case, and shall proceed to more and more complex ones continually, till I have exhausted what has occurred to me upon this subject.

This proposition, or first and simplest case of association, is manifest from innumerable common observations. Thus the names, smells, tastes, and tangible qualities of natural bodies, suggest their visible appearances to the fancy, *i. e.* excite their visible ideas; and, *vice versâ*, their visible appearances impressed on the eye raise up those powers of recon-

noitering their names, smells, tastes, and tangible qualities, which may not improperly be called their ideas, as above noted; and in some cases raise up ideas, which may be compared with visible ones, in respect of vividness. All which is plainly owing to the association of the several sensible qualities of bodies with their names, and with each other. It is remarkable, however, as being agreeable to the superior vividness of visible and audible ideas before taken notice of, that the suggestion of the visible appearance from the name, is the most ready of any other; and, next to this, that of the name from the visible appearance; in which last case, the reality of the audible idea, when not evident to the fancy, may be inferred from the ready pronunciation of the name. For it will be shewn hereafter, that the audible idea is most commonly a previous requisite to pronunciation. Other instances of the power of association may be taken from compound visible and audible impressions. Thus the sight of part of a large building suggests the idea of the rest instantaneously; and the sound of the words which begin a familiar sentence, brings the remaining part to our memories in order, the association of the parts being synchronous in the first case, and successive in the last.

It is to be observed, that, in successive associations, the power of raising the ideas is only exerted according to the order in which the association is made. Thus, if the impressions *A, B, C*, be always made in the order of the alphabet, *B* impressed alone will not raise *a*, but *c* only. Agreeably to which, it is easy to repeat familiar sentences in the order in which they always occur, but impossible to do it readily in an inverted one. The reason of this is, that the compound idea, *c, b, a*, corresponds to the compound sensation *C, B, A*; and therefore requires the impression of *C, B, A*, in the same manner as *a, b, c*, does that of *A, B, C*. This will, however, be more evident, when we

we come to consider the associations of vibratory motions, in the next proposition.

It is also to be observed, that the power of association grows feebler, as the number either of synchronous or successive impressions is increased, and does not extend, with due force, to more than a small one, in the first and simplest cases. But, in complex cases, or the associations of associations, of which the memory, in its full extent, consists, the powers of the mind, deducible from this source, will be found much greater than any person, upon his first entrance on these inquiries, could well imagine.

P R O P. XI.

Any Vibrations, A, B, C, &c. by being associated together a sufficient Number of Times, get such a Power over a, b, c, &c. the corresponding miniature Vibrations, that any of the Vibrations A, when impressed alone, shall be able to excite b, c, &c. the Miniatures of the Rest.

THIS proposition may be deduced from the foregoing, in the same manner as the ninth has been from the eighth.

But it seems also deducible from the nature of vibrations, and of an animal body. Let *A* and *B* be two vibrations, associated synchronically. Now, it is evident, that the vibration *A* (for I will, in this proposition, speak of *A* and *B* in the singular number, for the sake of greater clearness) will, by endeavouring to diffuse itself into those parts of the medullary substance which are affected primarily by the vibration *B*, in some measure modify and change *B*, so as to make *B* a little different from what it would be, if impressed alone. For the same reasons the vibration *A* will be a little affected, even in its primary seat,

by the endeavour of *B* to diffuse itself all over the medullary substance. Suppose now the vibrations *A* and *B* to be impressed at the same instant, for a thousand times; it follows, from the ninth proposition, that they will first over-come the disposition to the natural vibrations *N*, and then leave a tendency to themselves, which will now occupy the place of the original natural tendency to vibrations. When therefore the vibration *A* is impressed alone, it cannot be entirely such as the object would excite of itself, but must lean, even in its primary seat, to the modifications and changes induced by *B*, during their thousand joint impressions; and therefore much more, in receding from this primary seat, will it lean that way; and when it comes to the seat of *B*, it will excite *B*'s miniature a little modified and changed by itself.

Or thus: when *A* is impressed alone, some vibration must take place in the primary seat of *B*, both on account of the heat and pulsation of the arteries, and because *A* will endeavour to diffuse itself over the whole medullary substance. This cannot be that part of the natural vibrations *N*, which belongs to this region, because it is supposed to be over-ruled already. It cannot be that which *A* impressed alone would have propagated into this region, because that has always hitherto been over-ruled, and converted into *B*; and therefore cannot have begotten a tendency to itself. It cannot be any full vivid vibration, such as *B*, *C*, *D*, &c. belonging to this region; because all full vibrations require the actual impression of an object upon the corresponding external organ. And of miniature vibrations belonging to this region, such as *b*, *c*, *d*, &c. it is evident, that *b* has the preference, since *A* leans to it a little, even in its own primary seat, more and more, in receding from this, and almost entirely, when it comes to the primary seat of *B*. For the same reasons *B* impressed alone will excite *a*; and, in general,

neral, if *A*, *B*, *C*, &c. be vibrations synchronically impressed on different regions of the medullary substance, *A* impressed alone will, at last, excite *b*, *c*, &c. according to the proposition.

If *A* and *B* be vibrations impressed successively, then will the latter part of *A*, viz. that part which, according to the third and fourth propositions, remains, after the impression of the object ceases, be modified and altered by *B*, at the same time that it will a little modify and alter it, till at last it be quite over-powered by it, and end in it. It follows therefore, by a like method of reasoning, that the successive impression of *A* and *B*, sufficiently repeated, will so alter the medullary substance, as that when *A* is impressed alone, its latter part shall not be such as the sole impression of *A* requires, but lean towards *B*, and end in *b* at last. But *B* will not excite *a* in a retrograde order, since, by supposition, the latter part of *B* was not modified and altered by *A*, but by some other vibration, such as *C* or *D*. And as *B*, by being followed by *C*, may at last raise *c*, so *b*, when raised by *A*, in the method here proposed, may be also sufficient to raise *c*, inasmuch as the miniature *c* being a feeble motion, not stronger, perhaps, than the natural vibrations *N*, requires only to have its kind, place, and line of direction, determined by association, the heat and arterial pulsation conveying to it the requisite degree of strength. And thus *A* impressed alone, will raise *b*, *c*, &c. in successive associations, as well as in synchronous ones, according to the proposition.

It seems also, that the influence of *A* may, in some degree, reach through *B* to *C*; so that *A* of itself may have some effect to raise *c*, as well as by means of *b*. However, it is evident, that this chain must break off, at last, in long successions, and that sooner or later, according to the number and vigour of the repeated impressions. The power of minia-

ture vibrations to raise other miniatures may, perhaps, be made clearer to mathematicians, by hinting, that the efficacy of any vibration to raise any other, is not in the simple ratio of its vividness, but as some power thereof less than unity; for thus b may raise c , a weaker vibration than b , c may raise d , &c. with more facility than if the efficacy was in the simple ratio of the vividness, and yet so, that the series shall break off at last.

If the ninth proposition be allowed, we may prove this in somewhat a shorter and easier manner, as follows. Since the vibrations A and B are impressed together, they must, from the diffusion necessary to vibratory motions, run into one vibration; and consequently, after a number of impressions sufficiently repeated, will leave a trace, or miniature, of themselves, as one vibration, which will recur every now and then, from slight causes. Much rather, therefore, may the part b of the compound miniature $a+b$ recur, when the part A of the compound original vibration $A+B$ is impressed.

And as the ninth proposition may be thus made to prove the present, so it ought to be acknowledged and remarked here, that, unless the ninth be allowed, the present cannot be proved, or that the power of association is founded upon, and necessarily requires, the previous power of forming ideas, and miniature vibrations. For ideas, and miniature vibrations, must first be generated, according to the eighth and ninth propositions, before they can be associated, according to the tenth and this eleventh. But then (which is very remarkable) this power of forming ideas, and their corresponding miniature vibrations, does equally presuppose the power of association. For since all sensations and vibrations are infinitely divisible, in respect of time and place, they could not leave any traces or images of themselves, *i. e.* any ideas, or miniature vibrations, unless their infinitesimal parts did cohere

cohere together through joint impressi^on; *i. e.* associati^on. Thus, to mention a gross instance, we could have no proper idea of a horse, unless the particular ideas of the head, neck, body, legs, and tail, peculiar to this animal, stuck to each other in the fancy, from frequent joint impressi^on. And, therefore, in dreams, where complex associations are much weakened, and various parcels of visible ideas, not joined in nature, start up together in the fancy, contiguous to each other, we often see monsters, chimeras, and combinations, which have never been actually presented.

Association seems also necessary to dispose the medullary substance to this or that miniature vibration, in succession, after the miniatures of a large number of original vibrations have been generated.

Nor does there seem to be any precise limit which can be set to this mutual dependence of the powers of generating miniatures, and of association upon each other: however, they may both take place together, as the heart and brain are supposed to do, or both depend upon one simple principle; for it seems impossible, that they should imply one another, *ad infinitum*. There is no greater difficulty here than in many other cases of mutual indefinite implication, known and allowed by all. Nay, one may almost deduce some presumption in favour of the hypothesis here produced, from this mutual indefinite implication of its parts, so agreeable to the tenor of nature in other things. And it is certainly a presumption in its favour, that a less power of generating miniatures will be a foundation for a larger of a association, and *vice versa*, till, at last, the whole superstructure of ideas and associations observable in human life, may, by proceeding upwards according to analysis, and downwards according to synthesis, be built upon as small a foundation as we please. Thus we may observe, that neither does this eleventh proposition necessarily

require the ninth, in its full extent, nor *vice versa*, for their demonstration. The least miniatures, with the feeblest cohesions of their parts, will, by degrees, run into larger, with stronger cohesions, from the same principles; nor are there any visible limits to the influence and extent of these powers, supposing the natural faculties of the being under consideration sufficiently extended.

Let me add, that the generation of sensible ideas from sensations, and the power of raising them from association, when considered as faculties of the mind, are evident and unquestionable. Since therefore sensations are conveyed to the mind, by the efficiency of corporeal causes upon the medullary substance, as is acknowledged by all physiologists and physicians, it seems to me, that the powers of generating ideas, and raising them by association, must also arise from corporeal causes, and consequently admit of an explication from the subtle influences of the small parts of matter upon each other, as soon as these are sufficiently understood, which is farther evinced from the manifest influences of material causes upon our ideas and associations, taken notice of under the second proposition. And as a vibratory motion is more suitable to the nature of sensation than any other species of motion, so does it seem also more suitable to the powers of generating ideas, and raising them by association. However, these powers are evident independently, as just now observed; so that the doctrine of association may be laid down as a certain foundation, and a clue to direct our future inquiries, whatever becomes of that of vibrations.

P R O P. XII.

Simple Ideas will run into complex ones, by Means of Association.

IN order to explain and prove this proposition, it will be requisite to give some previous account of the manner in which simple ideas of sensation may be associated together.

Case 1. Let the sensation *A* be often associated with each of the sensations *B, C, D, &c.* *i. e.* at certain times with *B*, at certain other times with *C, &c.* it is evident, from the tenth proposition, that *A*, impressed alone, will, at last, raise *b, c, d, &c.* all together *i. e.* associate them with one another, provided they belong to different regions of the medullary substance; for if any two, or more, belong to the same region, since they cannot exist together in their distinct forms, *A* will raise something intermediate between them.

Case 2. If the sensations *A, B, C, D, &c.* be associated together, according to various combinations of twos, or even threes, fours, &c. then will *A* raise *b, c, d, &c.* also *B* raise *a, c, d, &c.* as in case the first.

It may happen, indeed, in both cases, that *A*, may raise a particular miniature, as *b*, preferably to any of the rest, from its being more associated with *B*, from the novelty of the impression of *B*, from a tendency in the medullary substance to favour *b, &c.* and, in like manner, that *b* may raise *c* or *d* preferably to the rest. However, all this will be over-ruled, at last, by the recurrency of the associations; so that any one of the sensations will excite the ideas of the rest, at the same instant, *i. e.* associate them together.

Case 3. Let *A, B, C, D, &c.* represent successive impressions, it follows from the tenth and eleventh propositions,

propositions, that *A* will raise *b*, *c*, *d*, &c. *B* raise *c*, *d*, &c. And though the ideas do not, in this case, rise precisely at the same instant, yet they come nearer together than the sensations themselves did in their original impression; so that these ideas are associated almost synchronically at last, and successively from the first. The ideas come nearer to one another than the sensations, on account of their diminutive nature, by which all that appertains to them is contracted. And this seems to be as agreeable to observation as to theory.

Case 4. All compound impressions $A+B+C+D$, &c. after sufficient repetition leave compound miniatures $a+b+c+d$, &c. which recur every now and then from slight causes, as well such as depend on association, as some which are different from it. Now, in these recurrences of compound miniatures, the parts are farther associated, and approach perpetually nearer to each other, agreeably to what was just now observed, *i. e.* the association becomes perpetually more close and intimate.

Case 5. When the ideas *a*, *b*, *c*, *d*, &c. have been sufficiently associated in any one or more of the foregoing ways, if we suppose any single idea of these, *a* for instance, to be raised by the tendency of the medullary substance that way, by the association of *A* with a foreign sensation or idea *X* or *x*, &c. this idea *a*, thus raised, will frequently bring in all the rest, *b*, *c*, *d*, &c. and so associate all of them together still farther.

And, upon the whole, it may appear to the reader, that the simple ideas of sensation must run into clusters and combinations, by association; and that each of these will, at last, coalesce into one complex idea, by the approach and commixture of the several compounding parts.

It appears also from observation, that many of our intellectual ideas, such as those that belong to the heads

heads of beauty, honour, moral qualities, &c. are, in fact, thus composed of parts, which, by degrees, coalesce into one complex idea.

And as this coalescence of simple ideas into complex ones is thus evinced, both by the foregoing theory, and by observation, so it may be illustrated, and farther confirmed, by the similar coalescence of letters into syllables and words, in which association is likewise a chief instrument. I shall mention some of the most remarkable particulars, relating to this coalescence of simple ideas into complex ones, in the following corollaries.

COR. 1. If the number of simple ideas which compose the complex one be very great, it may happen, that the complex idea shall not appear to bear any relation to these its compounding parts, nor to the external senses upon which the original sensations, which gave birth to the compounding ideas, were impressed. The reason of this is, that each single idea is over-powered by the sum of all the rest, as soon as they are all intimately united together. Thus, in very compound medicines, the several tastes and flavours of the separate ingredients are lost and over-powered by the complex one of the whole mass: so that this has a taste and flavour of its own, which appears to be simple and original, and like that of a natural body. Thus also, white is vulgarly thought to be the simplest and most uncompounded of all colours, while yet it really arises from a certain proportion of the seven primary colours, with their several shades, or degrees. And, to resume the illustration above-mentioned, taken from language, it does not at all appear to persons ignorant of the arts of reading and writing, that the great variety of complex words of languages can be analysed up to a few simple sounds.

COR. 2. One may hope, therefore, that, by pursuing and perfecting the doctrine of association, we may

may some time or other be enabled to analyse all that vast variety of complex ideas, which pass under the name of ideas of reflection, and intellectual ideas, into their simple compounding parts, *i. e.* into the simple ideas of sensation, of which they consist. This would be greatly analogous to the arts of writing, and resolving the colours of the sun's light, or natural bodies, into their primary constituent ones. The complex ideas which I here speak of, are generally excited by words, or visible objects; but they are also connected with other external impressions, and depend upon them, as upon symbols. In whatever way we consider them, the trains of them which are presented to the mind seem to depend upon the then present state of the body, the external impressions and the remaining influence of prior impressions and associations, taken together.

COR. 3. It would afford great light and clearness to the art of logic, thus to determine the precise nature and composition of the ideas affixed to those words which have complex ideas, in a proper sense, *i. e.* which excite any combinations of simple ideas united intimately by association; also to explain, upon this foundation, the proper use of those words, which have no ideas. For there are many words which are mere substitutes for other words, and many which are only auxiliaries. Now it cannot be said, that either of these have ideas, properly so called. And though it may seem an infinite and impossible task, thus to analyse the significations and uses of words, yet, I suppose, this would not be more difficult, with the present philological and philosophical helps to such a work, than the first making of dictionaries and grammars, in the infancy of philology. Perhaps it may not be amiss just to hint, in this place, that the four following classes comprise all the possible kinds into which words can be distinguished, agreeably to the plan here proposed :

1. Words

1. Words which have ideas, but no definitions.
2. Words which have both ideas and definitions.
3. Words which have definitions, but no ideas.
4. Words which have neither ideas nor definitions.

It is quite manifest, that words seen or heard, can raise no ideas in the mind, or vibrations in the brain, distinct from their visible and audible impressions, except as far as they get new powers from associations, either incidental ones, or arising from express design, as in definitions; and therefore, that all other ways of considering words, besides what is here suggested, are either false or imperfect.

COR. 4. As simple ideas run into complex ones by association, so complex ideas run into decomplex ones by the same. But here the varieties of the associations, which increase with the complexity, hinder particular ones from being so close and permanent, between the complex parts of decomplex ideas, as between the simple parts of complex ones: to which it is analogous, in languages, that the letters of words adhere closer together than the words of sentences, both in writing and speaking.

COR. 5. The simple ideas of sensation are not all equally and uniformly concerned in forming complex and decomplex ideas, *i. e.* these do not result from all the possible combinations of twos, threes, fours, &c. of all the simple ideas; but, on the contrary, some simple ideas occur in the complex and decomplex ones much oftener than others: and the same holds of particular combinations by twos, threes, &c. and innumerable combinations never occur at all in real life, and consequently are never associated into complex or decomplex ideas. All which corresponds to what happens in real languages; some letters, and combinations of letters, occur much more frequently than others, and some combinations never occur at all.

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COR. 6. As persons who speak the same language have, however, a different use and extent of words, so, though mankind, in all ages and nations, agree, in general, in their complex and decomplex ideas, yet there are many particular differences in them; and these differences are greater or less, according to the difference, or resemblance, in age, constitution, education, profession, country, age of the world, &c. *i. e.* in their impressions and associations.

COR. 7. When a variety of ideas are associated together, the visible idea, being more glaring and distinct than the rest, performs the office of a symbol to all the rest, suggests them, and connects them together. In this it somewhat resembles the first letter of a word, or first word of a sentence, which are often made use of to bring all the rest to mind.

COR. 8. When objects and ideas, with their most common combinations, have been often presented to the mind, a train of them, of a considerable length, may, by once occurring, leave such a trace, as to recur in imagination, and in miniature, in nearly the same order and proportion as in this single occurrence. For since each of the particular impressions and ideas is familiar, there will want little more for their recurrency, than a few connecting links; and even these may be, in some measure, supplied by former similar instances. These considerations, when duly unfolded, seem to me sufficient to explain the chief phænomena of memory; and it will be easily seen from them, that the memory of adults, and masters in any science, ought to be much more ready and certain than that of children and novices, as it is found to be in fact.

COR. 9. When the pleasure or pain attending any sensations, and ideas, is great, all the associations belonging to them are much accelerated and strengthened. For the violent vibrations excited in such cases, soon over-rule the natural vibrations, and leave

leave in the brain a strong tendency to themselves, from a few impressions. The associations will therefore be cemented sooner and stronger than in common cases; which is found agreeable to the fact.

COR. 10. As many words have complex ideas annexed to them, so sentences, which are collections of words, have collections of complex ideas, *i. e.* have decomplex ideas. And it happens, in most cases, that the decomplex idea belonging to any sentence, is not compounded merely of the complex ideas belonging to the words of it; but that there are also many variations, some oppositions, and numberless additions. Thus propositions, in particular, excite, as soon as heard, assent or dissent; which assent and dissent consist chiefly of additional complex ideas, not included in the terms of the proposition. And it would be of the greatest use, both in the sciences and in common life, thoroughly to analyse this matter, to shew in what manner, and by what steps, *i. e.* by what impressions and associations, our assent and dissent, both in scientific and moral subjects, is formed.

P R O P. XIII.

When simple Ideas run into a complex one, according to the foregoing Proposition, we are to suppose, that the simple miniature Vibrations corresponding to those simple Ideas run, in like Manner, into a complex miniature Vibration, corresponding to the resulting complex Idea.

THIS proposition is analogous to the ninth and eleventh, and may be deduced from the last, as they are from the eighth and tenth respectively. It is also an evidence and illustration of the second, shewing not only, that the state of the medullary substance is changed, according to the several natures of the

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the ideas which are presented to the mind; but also shewing, in general, of what kind this change is, and in what manner it is effected.

P R O P. XIV.

It is reasonable to think, that some of the complex Vibrations attending upon complex Ideas, according to the last Proposition, may be as vivid, as any of the sensory Vibrations excited by the direct Action of Objects.

For these complex vibrations may consist of so many parts co-existent and successive, and these parts may so alter and exalt one another, as that the resulting agitations in the medullary substance may no longer be miniature vibrations, but vivid ones, equal to those excited by objects impressed on the senses. This process may be farther favoured by a mixture of vivid real impressions among the ideas, by the irritability of the medullary substance, by a previous disposition to the vibrations to be excited, &c.

COR. 1. When the complex miniature vibrations are thus exalted in degree, we are to conceive, that the corresponding complex ideas are proportionally exalted, and so pass into intellectual affections and passions. We are therefore to deduce the origin of the intellectual pleasures and pains, which are the objects of these affections and passions, from the source here laid open.

COR. 2. Since the present proposition unfolds the nature of the affections and will, in the same manner, and from the same principles, as the twelfth does that of ideas, intellect, memory, and fancy, it follows, that all these are of the same original and consideration, and differ only in degree, or some accidental circumstances. They are all deducible from
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the external impressions made upon the senses, the vestiges or ideas of these, and their mutual connections by means of association, taken together, and operating on one another.

COR. 3. It follows also from this proposition, that the intellectual pleasures and pains may be greater, equal, or less, than the sensible ones, according as each person unites more or fewer, more vivid or more languid miniature vibrations, in the formation of his intellectual pleasures and pains, &c.

COR. 4. It is evident, that all the vibrations which belong to ideas, and intellectual affections, must reside in the brain, or even in the most internal parts of it, not in the spinal marrow, or nerves. The brain is therefore the seat of the rational soul, *i. e.* of the soul, as far as it is influenced by reasons and moral motives, even though we should admit, that the spinal marrow and nerves are, in part, the sensorium, or the seat of the sensitive soul; which is some argument, that this ought not to be admitted, but that the sensorium, in men at least, ought to be placed in the internal parts of the brain.

COR. 5. It is of the utmost consequence to morality and religion, that the affections and passions should be analysed into their simple compounding parts, by reversing the steps of the associations which concur to form them. For thus we may learn how to cherish and improve good ones, check and root out such as are mischievous and immoral, and how to suit our manner of life, in some tolerable measure, to our intellectual and religious wants. And as this holds, in respect of persons of all ages, so it is particularly true, and worthy of consideration, in respect of children and youth. The world is, indeed, sufficiently stocked with general precepts for this purpose, grounded on experience; and whosoever will follow these faithfully, may expect good general success. However, the doctrine of association, when traced

up to the first rudiments of understanding and affection, unfolds such a scene as cannot fail both to instruct and alarm all such as have any degree of interested concern for themselves, or of a benevolent one for others. It ought to be added here, that the doctrine of association explains also the rise and progress of those voluntary and semivoluntary powers, which we exert over our ideas, affections, and bodily motions (as I shall shew hereafter, *prop.* 21.); and, by doing this, teaches us how to regulate and improve these powers.

COR. 6. If beings of the same nature, but whose affections and passions are, at present, in different proportions to each other, be exposed for an indefinite time to the same impressions and associations, all their particular differences will, at last, be over-ruled, and they will become perfectly similar, or even equal. They may also be made perfectly similar, in a finite time, by a proper adjustment of the impressions and associations.

COR. 7. Our original bodily make, and the impressions and associations which affect us in passing through life, are so much alike, and yet not the same, that there must be both a great general resemblance amongst mankind, in respect of their intellectual affections, and also many particular differences.

COR. 8. Some degree of spirituality is the necessary consequence of passing through life. The sensible pleasures and pains must be transferred by association more and more every day, upon things that afford neither sensible pleasure nor sensible pain in themselves, and so beget the intellectual pleasures and pains.

COR. 9. Let the letters *a, b, c, d, e, &c.* represent the sensible pleasures; *x, y, and z,* the sensible pains, supposed to be only three in number; and let us suppose all these, both pleasures and pains, to be equal to one another: if now the ideas of these
sensible

sensible pleasures and pains be associated together, according to all the possible varieties, in order to form intellectual pleasures and pains, it is plain, that pleasure must prevail in all the combinations of seven or more letters; and also, that when the several parts of these complex pleasures are sufficiently united by association, the pains which enter their composition will no longer be distinguished separately, but the resulting mixed and complex pleasures appear to be pure and simple ones, equal in quantity to the excess of pleasure above pain, in each combination. Thus association would convert a state, in which pleasure and pain were both perceived by turns, into one in which pure pleasure alone would be perceived; at least, would cause the beings who were under its influence to an indefinite degree, to approach to this last state nearer than by any definite difference. Or, in other words, association, under the supposition of this corollary, has a tendency to reduce the state of those who have eaten of the tree of the knowledge of good and evil, back again to a paradisiacal one. Now, though the circumstances of mankind are not the same with those supposed in this corollary, yet they bear a remarkable resemblance thereto, during that part of our existence which is exposed to our observation. For our sensible pleasures are far more numerous than our sensible pains; and though the pains be, in general, greater than the pleasures, yet the sum total of these seems to be greater than that of those; whence the remainder, after the destruction of the pains by the opposite and equal pleasures, will be pure pleasure.

COR. 10. The intellectual pleasures and pains are as real as the sensible ones, being, as we have seen, nothing but the sensible ones variously mixed and compounded together. The intellectual pleasures and pains are also all equally of a factitious and acquired nature. We must therefore estimate all our pleasures

fures equally, by their magnitude, permanency, and tendency to procure others; and our pains in like manner.

COR. 11. The sensible pleasures and pains have a greater tendency to destroy the body, than the intellectual ones; for they are of a particular local nature, and so bear hard upon the organs which convey them. But the destruction of any one considerable part of the body is the destruction of the whole, from the sympathy of the parts; whereas the intellectual pleasures and pains, being collected from all quarters, do not much injure any organ particularly, but rather bring on an equable gradual decay of the whole medullary substance, and all the parts thereon depending.

COR. 12. This proposition, and its corollaries, afford some pleasing presumptions; such are, that we have a power of suiting our frame of mind to our circumstances, of correcting what is amiss, and improving what is right: that our ultimate happiness appears to be of a spiritual, not corporeal nature; and therefore that death, or the shaking off the gross body, may not stop our progress, but rather render us more expedite in the pursuit of our true end: that association tends to make us all ultimately similar; so that if one be happy, all must: and lastly, that the same association may also be shewn to contribute to introduce pure ultimate spiritual happiness, in all, by a direct argument, as well as by the just mentioned indirect one.

S E C T. III.

OF MUSCULAR MOTION, AND ITS TWO KINDS, AUTOMATIC AND VOLUNTARY; AND OF THE USE OF THE DOCTRINES OF VIBRATIONS AND ASSOCIATION, FOR EXPLAINING THESE RESPECTIVELY.

P R O P. XV.

It is probable, that muscular Motion is performed in the same general Manner as Sensation, and the Perception of Ideas.

FOR, first, sensation, the perception of ideas, and a locomotive faculty, *i. e.* muscular motion, are the three most eminent marks of distinction between the animal and vegetable world: therefore since it is already found, that the two first are performed by the same means, *i. e.* vibrations, there is some presumption, that the last will not require a different one.

Secondly, Of the two sorts of motion, viz. automatic and voluntary, the first depends upon sensation, the last upon ideas, as I shall shew particularly hereafter, and may appear, in general, to any one, upon a slight attention; whence it follows, that sensation, and automatic motion, must be performed in the same general manner, also the perception of ideas, and voluntary motion: and therefore, since sensation and perception, the two antecedents, agree in their causes, automatic and voluntary motion, the two consequents, *i. e.* all the four, must likewise.

Thirdly, It appears from the first and second propositions, that the white medullary substance is the

common instrument of sensation, ideas, and motion; and by the fifth, that this substance is uniform and continuous every where. Hence it follows, that the subtle motions excited in the sensory nerves, and medullary substance of the brain, during sensation and intellectual perception, must, of whatever kind they be, pass into the motory nerves; and when they are arrived there, it is probable, that they must cause the contraction of the muscles, both because otherwise their arrival at the motory nerves would be superfluous, and because some such subtle motions are required for this purpose.

COR. 1. All arguments therefore which prove the performance of sensation and intellectual perception, by means of vibrations of the small medullary particles, must infer, that muscular motion is performed by vibrations also. And conversely, if vibrations can be shewn to take place in muscular motion, they must also be instrumental in sensation and intellectual perception.

COR. 2. There are certain experiments and observations which favour the supposition of the performance of muscular motion by subtle agitations in the small particles of the muscular fibres, *i. e.* by vibratory motions. It follows therefore, that these experiments and observations are some additional evidence for the existence of sensory and ideal vibrations, as above explained. Such are, that the motion of the heart, and of other muscles, may be renewed in dying animals, and those that are newly dead, by heat, injection of a fluid, and punctures, it being easy to be conceived, that the two last causes should put the particles of the fibres into agitations for a short time, *i. e.* till they can recover their equilibrium, by altering their distances, and mutual actions: and the first cause, *i. e.* heat, is, by the common consent of all, judged to consist in, and to cause, subtle vibratory motions. It is also difficult to assign any other
action

action which these causes can have. In like manner the alternate contractions and relaxations of the hearts of frogs, vipers, and some other animals, which continue for long spaces of time after these have been entirely separated from their bodies, seem utterly inexplicable upon any of the common suppositions, but follow easily from the doctrine of vibrations, as it is applied to muscular motion, in the two next propositions.

COR. 3. Since the same motion which occasions sensation, and intellectual perception, passes through the seats of these into the motory nerves, in order to excite there the automatic and voluntary motions, thus pervading the whole medullary substance, in various ways, according to the variety of the circumstances, but in all with the greatest precision and exactness, it follows, that this must be a vibratory one, and that of the most subtle kind. For the same excess of softness, which renders the medullary substance totally inelastic as to sense, and consequently unfit for the grosser vibrations of the particles of the first or largest order (by the vibrations of which, in sonorous bodies, it seems, that sound is excited in the air), may render it more susceptible of vibrations, in the particles of the second, third, &c. orders; and if we suppose a proper ultimate structure in the several parts of the medullary substance, these vibrations may be conveyed with all that precision and variety which the phænomena require. And, unless we do suppose some such subtle vibrations as these, it will be extremely difficult to conceive, how so soft a pulp as the medullary substance is, should be the common instrument of sensation, thought, and motion; which yet all physicians and philosophers must allow, according to the first and second propositions. If we set aside subtle vibratory motions, the impulse of the objects of sense can communicate nothing, as it seems, to so soft a substance, but an uniform pressure, susceptible

of few or no modifications, and consequently highly unsuitable to the great variety of the phænomena that are to be solved by it. This argument therefore tends to shew, that sensation, thought, and motion, must all be performed by vibrations.

P R O P. XVI.

The Phænomena of muscular Contraction appear to be sufficiently agreeable to the Doctrine of Vibrations.

IN order to shew this, let us make the following suppositions :

First, That vibrations descend along the motory nerves, *i. e.* the nerves which go to the muscles, in some such manner as sound runs along the surfaces of rivers, or an electrical virtue along hempen strings.

Secondly, That these vibrations, when they arrive at the muscular fibres, are communicated to them, so that the small particles of these fibres shall be agitated with like vibrations.

Thirdly, That the vibrations thus excited in the fibres, put into action an attractive virtue, perhaps of the electrical kind, which lies concealed in the particles of the fibres, or in the blood globules, or both. That the blood globules of animals are electrical, may be conjectured from the electricity of those of the muscle-shell fish, observed by Dr. Hales ; and that the red blood has a principal share in muscular contraction, is highly probable, from the red colour of all the great muscles of the body, and from the weakness of all young animals, and of such as want a due share of red blood. At the same time, it appears from exanguious and transparent animals, that pale fibres, and colourless fluids, have all the necessary requisites for muscular contraction, in certain degrees.

Fourthly,

Fourthly, We must now suppose, in consequence of the three foregoing suppositions, that each muscular fibre, and consequently the whole muscle, is made shorter by this increase of attraction in its particles; whilst yet their approach to each other is so small, as that the whole bulk of the muscle is but little diminished; for though the length of the muscle is lessened, its other dimensions are increased.

Fifthly, If we suppose the small ultimate fibres of the muscles to bend alternately to the right and left, as an eel does, at exceedingly short intervals, agreeably to Dr. *Lower*, this may somewhat assist us to conceive in what manner a muscle may be shortened, and yet so increased in breadth and thickness, as to remain of nearly the same dimensions. For if these flexures be increased by the increase of the attraction of the parts, the whole muscle will become shorter and thicker, as it is found to be in contraction; and conversely when the flexures are drawn out, the muscle will be longer and thinner, *i. e.* in a state of relaxation. The small wrinkles which have been observed in the muscular fibres, by *Leeuwenhoek*, and others, the wavings and curls which frequently appear to the eye in muscles, after boiling or roasting, and the rhomboidal pinnulae taken notice of by Dr. *Hales* in the abdominal muscles of a living frog, when under contraction, all seem to favour this fifth supposition.

Dr. *Pemberton* conjectures, that the cause of the contraction of muscular fibres is no other than the common cause of the cohesion of the small particles of the muscular fibres increased. And this seems very probable; for the muscles are hard during contraction, soft during relaxation; and hardness and softness are evidently nothing but variations in the cohesion of the small particles of bodies. Neither is this conjecture at all repugnant to the supposition of an electrical attraction above made, or to the doctrine

trine of vibrations; for electricity may reach to small distances, without being excited by friction, and flow from the same principle as the cohesion of bodies, as Sir *Isaac Newton* has observed. It may therefore be the general cause of cohesion, and may be excited in the muscular fibres in an extraordinary degree, whenever extraordinary vibrations are communicated to them. Or, if we suppose the cause of cohesion to be something distinct from electricity, it may, however, be increased by vibrations of the small cohering particles.

P R O P. XVII.

That Propensity to alternate Contraction and Relaxation, which is observed in almost all the Muscles of the Body, admits of a Solution from the Doctrine of Vibrations.

FOR, when the fibres are in a state of contraction, they are hard; and this hardness, if it be supposed to extend to the small particles (which is no unreasonable supposition), must render the particles of these particles, *i. e.* the particles supposed in these propositions to be agitated with vibrations, indisposed to receive these vibrations; but the free admission of these vibrations is by supposition the cause which excites the attractions of the particles, and the consequent contraction of the muscle. It follows therefore, that the hardness which impedes these vibrations, must also lessen the attraction and contraction; or, in other words, that the contraction of a muscle, when carried to a certain degree, must check itself, and bring on a relaxation, after a time sufficient for the proper causes to take effect.

In like manner, when a muscle is relaxed, the vibrations which descend along the motory nerves, pass freely into the muscular fibres, increase the attractions
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of the particles, and bring on the opposite state, that of contraction; and so on alternately.

The fibres of the relaxed muscle may also be considered as under a state of distention to a certain degree, and consequently as liable to an increase of vibrations upon this account. To which we may farther add, that since vibrations are hindered from passing into the contracted muscle, in the manner just now explained, they will pass with greater force into the relaxed one, from the place of the common derivation of their nerves, wherever there are antagonist muscles, that derive nerves from the same trunk, as in the limbs, and muscles of respiration.

COR. It appears from this method of considering the contractions and relaxations of muscles, that there is a certain degree of hardness or contraction in muscular fibres, which may be supposed just to balance each degree of force with which vibrations descend into the muscular fibres; and that, while this equilibrium subsists, the contraction can neither be increased nor abated.

P R O P. XVIII.

The Vibrations, of which an Account has been given in this Chapter, may be supposed to afford a sufficient Supply of motory Vibrations, for the Purpose of contracting the Muscles.

In order to make this appear, it will be proper to distinguish the motory vibrations, or those which descend along the nerves of the muscles into their fibres, into the five following classes:

First then, we are to conceive, that those sensory vibrations which are excited in the external organs, and ascend towards the brain, when they arrive, in their ascent, at the origins of motory nerves, as they arise from the same common trunk, plexus, or ganglion,

gion, with the sensory ones affected, detach a part of themselves at each of these origins down the motory nerves; which part, by agitating the small particles of the muscular fibres, in the manner explained in the sixteenth proposition, excites them to contraction.

Secondly, The remainder of the sensory vibrations, which arrives at the brain, not being detached down the motory nerves in its ascent thither, must be diffused over the whole medullary substance. It will therefore descend from the brain into the whole system of motory nerves, and excite some feeble vibrations, at least, in them. The same may be observed of ideal vibrations generated in the brain by association; these must pervade the whole medullary substance, and consequently affect all the motory nerves in some degree.

Thirdly, The heat of the blood, and pulsation of the arteries, which pass through the medullary substance, must always excite, or keep up, some vibrations in it; and these must always descend into the whole system of muscles. And I apprehend, that from these two last sources, taken together, we may account for that moderate degree of contraction, or tendency thereto, which is observable in all the muscles, at least in all those of healthy adults, during vigilance.

Fourthly, When vivid vibrations are excited in membranes of an uniform texture, by a stimulus of any kind, they seem to run over the whole extent of such membranes, and by this means to have a great influence in contracting all the muscles that lie near any part of this membrane, though they be remote from the place of the stimulus. The manner in which this is effected, I conceive to be as follows: the repeated or continued action of the stimulus diffuses vibrations from the place of its action over the whole membrane, which, by their reciprocal influences, become

come equal, or nearly so, in every part of it, and are, at last, so exalted, as to contract every part. As soon as this contraction takes place, the vibrations in its small particles must cease for reasons given above. They will therefore be propagated almost instantaneously over the neighbouring muscles, from the nervous communications between the membrane and the neighbouring muscles; by which all changes made in the nerves of the membrane must affect those of the neighbouring muscles. As therefore during the vivid vibrations of the particles of the membrane, we must suppose some to be propagated into the neighbouring muscles, agreeably to the first article of this proposition, so, upon their sudden cessation, such a change may reasonably be supposed, in the communicating nervous fibrils, as shall agitate the æther contained in them with much more vivid vibrations than before; and these vibrations must now pass into the muscles alone, since the contraction of the membrane hinders them from returning into it. I shall hereafter produce several examples of this process, in detail. It may suffice, at present, just to mention the action of sneezing, and to desire the reader to compare this action, in a cursory way, with the foregoing account.

Fifthly, I have, in the last article, shewn how a cessation of vibrations in the particles of a membrane, may increase those in the neighbouring muscles. But it seems also, that a cessation of vibrations in any other considerable part of the body, from whatever cause it proceeds, has a like tendency; and that this tendency is deducible from the change made in the nerves of the part affected, and thence propagated into the communicating branches, or even into the whole medullary substance. The yawnings and stretchings of persons disposed to sleep, the convulsive respiration of those that are just fallen asleep, and the convulsive motions which attend the extinction

tion of the senses in epileptic fits, and the near approaches of death, may be derived, perhaps, in part, from this source, in part from some of the foregoing.

P R O P. XIX.

The automatic Motion seem to admit of a commodious Explanation, from the three last Propositions taken together.

THE particular detail of this obscure and intricate matter will be attempted in the proper places of the next chapter, which will contain the application of the general positions concerning sensation and motion, in this, to each of the most remarkable phænomena considered separately. I will, however, present the reader here with a short sketch, to enable him to form some notion of the manner and plausibility of the attempt.

The ordinary motions of the heart appear to arise from the second and third classes of motory vibrations, mentioned in the last proposition; and it is remarkable, that its motions are found to be, in general, and *ceteris paribus*, stronger or weaker, as the sum total of these two classes is greater or less. The systole and diastole succeed each other, from the causes assigned in the seventeenth proposition. We are to conceive, however, that both the influx of the venal blood into the ventricles, and of the arterial into the coronary vessels, have a considerable share in bringing on the systole, in the way of distention and irritation.

May we not conjecture, from that experiment of Dr. Hook's, in which he kept a dog alive, by a mere continued stream of fresh air passing through the lungs, without any such alternate motion of the chest as takes place in common respiration, that one principal

principal use of the air, which is an electric *per se*, in respiration, is to restore to the blood, as it passes through the lungs, that electricity which it has lost in circulating through the body? For, upon this supposition, the blood which arrives at the left ventricle, will, in cessations of respiration, and also where foul air is respired, want its due electricity; whence, according to *prop.* 16. the muscles, and especially the heart, will want one of the principal requisites for contraction. However, convulsive motions may ensue after a syncope, from the fifth class of motory vibrations.

It is remarkable here, that the hearts of frogs, vipers, and several other such animals, as can live in great degrees of cold, and without respiration, continue to beat, as has been taken notice of above, for a long time after they are taken out of their bodies. We must therefore suppose, that the fibres of their hearts, and the blood globules which remain in them, are endued with an electric, or other attractive virtue, of a more durable kind than the fibres and blood globules of the more perfect animals; also, that this virtue may be put into action by a less degree of heat. All which is very agreeable to the other circumstances of their œconomy.

Respiration and crying are excited in the new-born child from the cold, handling of the midwife, and other vivid sensations impressed immediately upon its coming into the world. These vivid sensations put the whole system of muscles, or at least those of the trunk and larynx, into action at once, as far as their mutual antagonism will permit, the stronger set of conspiring muscles over-powering the weaker for a certain short time, and then after their force is exhausted, according to *prop.* 17. giving way for a shorter time to the weaker. But this alternate action of the muscles of the trunk and larynx will be an imperfect kind of respiration, with crying, as
may

may be easily seen from the disposition of the muscles. Respiration is afterwards kept up, partly by the propensity of the muscles to alternate action, explained *prop.* 17. partly, perhaps, by the power of habit, *i. e.* association; partly by the renewal of vivid impressions; and partly, as it seems, by vibrations excited in the pleura and peritonæum, and thence communicated to the diaphragm, and to the muscles of the breast and belly.

That the last cause has a real efficacy, may appear from the following instance. Let respiration be supposed to be at a stand for a small time, on account of the person's running, or exerting an act of great strength. It is evident, that the blood will both be accumulated in the lungs, and heated there, during this interruption of respiration, since respiration both ventilates the blood, and promotes its motion through the lungs. The external membrane of the lungs will therefore be both distended and heated, *i. e.* will have an increase of vibrations communicated to it. But this membrane is continuous to the pleura, and, indeed, is the same membrane with it. An increase of vibrations will therefore be communicated to the pleura, and consequently to the diaphragm, and muscles of the breast, which it invests.

The peristaltic motion of the intestines is, in part, to be deduced from the second and third classes of motory vibrations, in the same manner as the motion of the heart, since that motion, like this, returns at intervals incessantly. And there is reason to believe, that vigorous vibrations, either of the sensory or ideal kind, impart an extraordinary degree of activity to the stomach and bowels. However, they derive also a great part of their motions, probably the major-part, from the impressions which the aliment, bile, and fæces, make upon the villous coat, the vibrations excited by these impressions both running directly into the muscular coat, for the pur-

pose of contracting that part which adjoins to the seat of impression, and also running upwards and downwards along the villous coat, so as to exert some efficacy at a distance from this seat.

It is very remarkable that the pale fibres of the intestines, in men, and many other animals, preserve their power of alternate contraction and relaxation for a considerable time after death, whereas the red fleshy muscles of the same animals lose theirs soon after the effusion of their blood. It is a phænomenon of a like kind with this, that the whole muscular system of some animals, that are exanguious, or nearly so, retain their activity for a considerable time after these animals are cut into pieces. And both may serve to intimate, that the electricity, or other attractive virtue, of pale fibres and fluids, at the same time that it is feebler than that of red ones, is, however, of a more durable kind, and, as was observed above of the hearts of frogs and vipers, capable of being put into action by a less degree of heat.

The actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the feces and urine, with others of a like nature, are to be deduced from the first and fourth classes of motory vibrations, *i. e.* either from those vibrations which first ascend up the sensory nerves, and then are detached down the motory nerves, which communicate with these by some common trunk, plexus, or ganglion, or else from those vibrations that run along the surfaces of uniform membranes, and so affect all the muscles which lie contiguous to any part of these membranes. It is a strong argument in favour of the hypothesis here delivered, that all the above-mentioned motions arise in the neighbourhood of vivid sensations, increase when they increase, and languish when they languish.

In examining this hypothesis by the actions of sneezing, swallowing, and coughing, regard must be had to the nose, uvula, and epiglottis, respectively, as being extreme and pointed parts, and consequently liable to be affected with extraordinary vibrations, agreeably to the ninth phænomenon of the sixth proposition.

In like manner, the numerous plexuses and ganglions of the eighth pair of nerves and intercostal nerve must have great influence in the motions and functions of the parts contained in the thorax and belly.

As the motory vibrations of the second and third classes are of a gentle kind, for the most part, and descend constantly into the whole system of the muscles, it may be expected, that young children should move all their limbs at times, with some irregular kind of succession, from this cause. And this seems to be the fact. Strong contractions of the limbs are often excited by frictions, gripes, and other vivid sensations; but then the motory vibrations here are those of the first and fourth classes. General convulsions, from acidities, and other irritations in the bowels, seem to be excited in the same way, the intercostal nerve serving to communicate the vibrations with more readiness to the muscles of the trunk and limbs.

It appears to me also, that the intercostal nerve, which makes those of each side a separate system, as it were, has some share in determining hemiplegias to one side. In like manner, the great brachial and crural ganglions make all the nerves of the same limb sympathize with one another.

Whether the nerves of the same names throughout the body have not some sympathetic influences over each other, may be doubted. If those of the right side arise from the left part of the brain, and *vice versâ*, which seems to be the opinion of the best anatomists,

anatomists, then one would imagine, that the homonymous nerves of the right and left sides must, in crossing over, lie somewhere contiguous to each other, and so impart vibrations to each other. And there seem to be some facts from whence this may be inferred; but we cannot expect to be able to distinguish, with certainty, so feeble an influence, amidst so many others that are far stronger.

Yawning and stretching may, perhaps, when considered in all their circumstances, take in all the five classes of motory vibrations. When they happen in the attacks of fever-fits, and other morbid cases, the first seems to be owing to pretty sudden and strong contractions in the membrane of the mouth, fauces, aspera arteria, and oesophagus; the last to contractions in the whole skin.

As the bowels derive their peristaltic motion, in part, from the second and third classes, so it seems, that the secretory and excretory vessels of the glands must be constantly agitated with a like motion, from the same causes, performing their ordinary secretions and excretions thereby. Their extraordinary ones are generally owing to irritations in the membranes, in which the mouths of their excretory vessels lie. And this agrees remarkably with the doctrine of vibrations. For the vivid vibrations excited in the membranes by the irritating cause must diffuse themselves every way; and when they come to the mouths of the excretory vessels, penetrate them, and, by passing up into the vessels, both excretory and secretory, greatly increase their peristaltic motion, and, by consequence, their secretions and excretions. All this seems equally to hold, in respect of the exhaling and absorbing vessels dispersed throughout the body.

The external motions of the eyes in young children are probably owing, in part at least, to the immediate action of light upon the tendinous expansions of the four strait muscles, and particularly upon

those of the *adducens* and *abducens*! But the light which passes through the pupil seems also to have some share, as will be shewn hereafter. As to the internal motions, it appears, that the light which falls upon the *cornea* and *uvea* must excite the greater and lesser rings to contraction, in proportion to its strength, and consequently prepare the eye to see distinctly, at different distances, in the manner explained by Dr. Jurin. The hypothesis of this proposition does therefore give and receive light from his ingenious theory of this matter.

The two muscles which relax the *membrana tympani*, are much more exposed to the air than the *musculus internus*, or the *musculus stapedis*. When therefore the air is agitated with strong vibrations, as in loud sounds, it will excite the first named muscles to action, and consequently relax the *membrana tympani*, as it ought to do. For what reasons the last named muscles are contracted in feeble sounds, is a question of a more difficult nature, as is the parallel one in the eye, viz. why the radiated fibres of the *uvea* are contracted in small degrees of light, so as then to dilate the pupil.

The reader is desired to take notice, that, in all the instances of this proposition, I consider the motions as merely automatic. Their voluntary and semivoluntary state will be accounted for in the two next propositions.

P R O P. XX.

All that has been delivered above, concerning the Derivation of ideal Vibratiuncles from sensory Vibrations and concerning their Associations, may be fitly applied to motory Vibrations and Vibratiuncles.

THIS proposition is the immediate consequence of admitting the doctrines of vibrations and association, in the manner in which they have been asserted in the foregoing propositions. It contains the theory of the voluntary and semivoluntary motions; to facilitate the application of which theory in the next proposition, I shall deliver the principal cases of this, in the following corollaries.

COR. 1. The motory vibrations of the five classes mentioned *prop.* 18. will generate a propensity to corresponding motory vibratiuncles.

COR. 2. These motory vibratiuncles will affect the brain, as well as the motory nerves along which they descend; and, indeed, their descent along the motory nerves will be principally owing to their being first excited in the brain. This is sufficiently evident in the motory vibratiuncles which are derived from the motory vibrations of the second and third classes. As to the motory vibrations of the other classes, it is evident, that the brain is strongly affected by the sensory vibrations which give birth to them, and consequently, that a proportional affection of the brain must take place in the motory vibratiuncles derived from them.

COR. 3. The motory vibratiuncles will cohere to one another, by associations both synchronous and successive. Hence the simple parts, of which complex and decomplex motions are compounded, may cohere closely, and succeed readily to each other.

COR. 4. The motory vibratiuncles will also cohere to ideal ones by association. Common ideas may therefore excite motory vibratiuncles, and consequently be able to contract the muscles, provided the active powers lodged in their fibres and blood globules be sufficiently exalted for this purpose.

COR. 5. If we suppose the ideal vibratiuncles to be so much increased, from the causes mentioned *prop.* 14. as to be equal in strength to the usual sensory vibrations, the motory vibratiuncles connected with them by association must be supposed to be increased proportionably. Hence ideas may occasion muscular motions of the same strength with the automatic motions.

COR. 6. The third and last connection of the motory vibratiuncles is that with sensory vibrations, foreign to them, *i. e.* such as had no share in generating the motory vibratiuncles under consideration. Particular motions of the body may therefore by association be made to depend upon sensations, with which they have no natural and original connection.

COR. 7. As muscular motion has three connections deducible from association, viz. those mentioned in the third, fourth, and sixth corollaries, so the sensations and ideas have the same three connections. Hence the whole doctrine of association may be comprised in the following theorem, viz.

If any sensation A, idea B, or muscular motion C, be associated for a sufficient number of times with any other sensation D, idea E, or muscular motion F, it will, at last, excite d, the simple idea belonging to the sensation D, the very idea E, or the very muscular motion F.

The reader will observe, that association cannot excite the real sensation *D*, because the impression of the sensible object is necessary for this purpose. However, in certain morbid cases, the idea is magnified so as to equal, or even over-power, sensible impressions.

P R O P.

P R O P. XXI.

The voluntary and semivoluntary Motions are deducible from Association, in the Manner laid down in the last Proposition.

IN order to verify this proposition, it is necessary to inquire, what connections each automatic motion has gained by association with other motions, with ideas, or with foreign sensations, according to the third, fourth, and sixth corollaries of the last proposition, so as to depend upon them, *i. e.* so as to be excited no longer, in the automatic manner described in the nineteenth proposition, but merely by the previous introduction of the associated motion, idea, or sensation. If it follows that idea, or state of mind (*i. e.* set of compound vibratiuncles), which we term the will, directly, and without our perceiving the intervention of any other idea, or of any sensation or motion, it may be called voluntary, in the highest sense of this word. If the intervention of other ideas, or of sensations and motions (all which we are to suppose to follow the will directly), be necessary, it is imperfectly voluntary; yet still it will be called voluntary, in the language of mankind, if it follow certainly and readily upon the intervention of a single sensation, idea, or motion, excited by the power of the will: but if more than one of these be required, or if the motion do not follow with certainty and facility, it is to be esteemed less and less voluntary, semivoluntary, or scarce voluntary at all, agreeably to the circumstances. Now, if it be found, upon a careful and impartial inquiry, that the motions which occur every day in common life, and which follow the idea called the will, immediately or mediately, perfectly or imperfectly, do this, in proportion to the number and degree of strength in the associations,

this will be sufficient authority for ascribing all which we call voluntary in actions to association, agreeably to the purport of this proposition. And this, I think, may be verified from facts, as far as it is reasonable to expect, in a subject of inquiry so novel and intricate.

In the same manner as any action may be rendered voluntary, the cessation from any, or a forcible restraint upon any, may be also, viz. by proper associations with the feeble vibrations in which inactivity consists, or with the strong action of the antagonist muscles.

After the actions, which are most perfectly voluntary, have been rendered so by one set of associations, they may, by another, be made to depend upon the most diminutive sensations, ideas, and motions, such as the mind scarce regards, or is conscious of; and which therefore it can scarce recollect the moment after the action is over. Hence it follows, that association not only converts automatic actions into voluntary, but voluntary ones into automatic. For these actions, of which the mind is scarce conscious, and which follow mechanically, as it were, some precedent diminutive sensation, idea, or motion, and without any effort of the mind, are rather to be ascribed to the body than the mind, *i. e.* are to be referred to the head of automatic motions. I shall call them automatic motions of the secondary kind, to distinguish them both from those which are originally automatic, and from the voluntary ones; and shall now give a few instances of this double transmutation of motions, viz. of automatic into voluntary, and of voluntary into automatic.

The fingers of young children bend upon almost every impression which is made upon the palm of the hand, thus performing the action of grasping, in the original automatic manner. After a sufficient repetition of the motory vibrations which concur in this action, their vibratiuncles are generated, and associated

ciated strongly with other vibrations or vibratiuncles, the most common of which, I suppose, are those excited by the sight of a favourite play thing which the child uses to grasp, and hold in his hand. He ought, therefore, according to the doctrine of association, to perform and repeat the action of grasping, upon having such a play thing presented to his sight. But it is a known fact, that children do this. By pursuing the same method of reasoning, we may see how, after a sufficient repetition of the proper associations, the sound of the words *grasp*, *take hold*, &c. the sight of the nurse's hand in a state of contraction, the idea of a hand, and particularly of the child's own hand, in that state, and innumerable other associated circumstances, *i. e.* sensations, ideas, and motions, will put the child upon grasping, till, at last, that idea, or state of mind which we may call the will to grasp, is generated, and sufficiently associated with the action to produce it instantaneously. It is therefore perfectly voluntary in this case; and, by the innumerable repetitions of it in this perfectly voluntary state, it comes, at last, to obtain a sufficient connection with so many diminutive sensations, ideas, and motions, as to follow them in the same manner as originally automatic actions do the corresponding sensations, and consequently to be automatic secondarily. And, in the same manner, may all the actions performed with the hands be explained, all those that are very familiar in life passing from the original automatic state through the several degrees of voluntariness till they become perfectly voluntary, and then repassing through the same degrees in an inverted order, till they become secondarily automatic on many occasions, though still perfectly voluntary on some, *viz.* whensoever an express act of the will is exerted.

I will, in the next place, give a short account of the manner in which we learn to speak, as it may be deduced from the foregoing proposition. The new-born

born child is not able to produce a sound at all, unless the muscles of the trunk and larynx be stimulated thereto by the impression of pain on some part of the body. As the child advances in age, the frequent returns of this action facilitate it; so that it recurs from less and less pains, from pleasures, from mere sensations, and lastly, from slight associated circumstances, in the manner already explained. About the same time that this process is thus far advanced, the muscles of speech act occasionally, in various combinations, according to the associations of the motory vibratiuncles with each other. Suppose now the muscles of speech to act in these combinations at the same time that sound is produced from some agreeable impression, a mere sensation, or a slight associated cause, which must be supposed to be often the case, since it is so observable, that young children, when in a state of health and pleasure, exert a variety of actions at the same time. It is evident, that an articulate sound, or one approaching thereto, will sometimes be produced by this conjoint action of the muscles of the trunk, larynx, tongue, and lips; and that both these articulate sounds, and inarticulate ones, will often recur, from the recurrence of the same accidental causes. After they have recurred a sufficient number of times, the impression which these sounds, articulate and inarticulate, make upon the ear, will become an associated circumstance (for the child always hears himself speak, at the same time that he exerts the action) sufficient to produce a repetition of them. And thus it is, that children repeat the same sounds over and over again, for many successions, the impression of the last sound upon the ear exciting a fresh one, and so on, till the organs be tired. It follows therefore, that if any of the attendants make any of the sounds familiar to the child, he will be excited from this impression, considered as an associated circumstance, to return it. But the attendants

tendants make articulate sounds chiefly; there will therefore be a considerable balance in favour of such, and that of a growing nature: so that the child's articulate sounds will be more and more frequent every day—his inarticulate ones grow into disuse. Suppose now, that he compounds these simple articulate sounds, making complex ones, which approach to familiar words at some times, at others such as are quite foreign to the words of his native language, and that the first get an ever-growing balance in their favour, from the cause just now taken notice of; also, that they are associated with visible objects, actions, &c. and it will be easily seen, that the young child ought, from the nature of association, to learn to speak much in the same manner as he is found in fact to do. Speech will also become a perfectly voluntary action, *i. e.* the child will be able to utter any word or sentence proposed to him by others, or by himself, from a mere exertion of the will, as much as to grasp: only here the introductory circumstance, viz. the impression of the sound on the ear, the idea of this sound, or the preceding motion in pronouncing the preceding word, is evident; and therefore makes it probable, that the same thing takes place in other cases. In like manner, speech, after it has been voluntary for a due time, will become secondarily automatic, *i. e.* will follow associated circumstances, without any express exertion of the will.

From the account here given of the actions of handling and speaking, we may understand in what manner the first rudiments are laid of that faculty of imitation, which is so observable in young children. They see the actions of their own hands, and hear themselves pronounce. Hence the impressions made by themselves on their own eyes and ears become associated circumstances, and consequently must, in due time, excite to the repetition of the actions. Hence like impressions made on their eyes and ears by others,

others, will have the same effect; or, in other words, they will learn to imitate the actions which they see, and the sounds which they hear.

In the same manner may be explained the evident powers which the will has over the actions of swallowing, breathing, coughing, and expelling the urine and fæces, as well as the feeble and imperfect ones over sneezing, hiccoughing, and vomiting. As to the motion of the heart, and peristaltic motion of the bowels, since they are constant, they must be equally associated with every thing, *i. e.* peculiarly so with nothing, a few extraordinary cases excepted. They will therefore continue to move solely in the original automatic manner, during the whole course of our lives. However, association may, perhaps, have some share in keeping these motions, and that of respiration, up for a time, when the usual automatic causes are deficient in any measure; and may thus contribute to their equability and constancy. It seems certain, at least, that where unequable and irregular motions of the heart and bowels are generated, and made to recur for a sufficient number of times, from their peculiar causes, in full quantity, a less degree of the same causes, or even an associated circumstance, will suffice to introduce them afterwards. And the same thing may be observed of hysteric and epileptic fits. These recur from less and less causes perpetually, in the same manner, and for the same reasons, as original automatic motions are converted into voluntary ones.

I will add one instance more of the transition of voluntary actions into automatic ones of the secondary kind, in order to make that process clearer, by having it singly in view. Suppose a person who has a perfectly voluntary command over his fingers, to begin to learn to play upon the harpsicord: the first step is to move his fingers from key to key, with a slow motion, looking at the notes, and exerting an
express

express act of volition in every motion. By degrees the motions cling to one another, and to the impressions of the notes, in the way of association so often mentioned, the acts of volition growing less and less express all the time, till at last they become evanescent and imperceptible. For an expert performer will play from notes, or ideas laid up in the memory, or from the connection of the several complex parts of the decomplex motions, some or all; and, at the same time, carry on a quite different train of thoughts in his mind, or even hold a conversation with another. Whence we may conclude, that the passage from the sensory, ideal, or motory vibrations which precede, to those motory ones which follow, is as ready and direct, as from the sensory vibrations to the original automatic motions corresponding to them; and consequently, that there is no intervention of the idea, or state of mind, called will. At least, the doctrine of association favours this, and the fact shews, that there is no perceptible intervention, none of which we are conscious.

And thus, from the present proposition, and the nineteenth taken together, we are enabled to account for all the motions of the human body, upon principles which, though they may be fictitious, are, at least, clear and intelligible. The doctrine of vibrations explains all the original automatic motions, that of association the voluntary and secondarily automatic ones. And, if the doctrine of association be founded in, and deducible from, that of vibrations, in the manner delivered above, then all the sensations, ideas, and motions, of all animals, will be conducted according to the vibrations of the small medullary particles. Let the reader examine this hypothesis by the facts, and judge for himself. There are innumerable things, which, when properly discussed, will be sufficient tests of it. It will be necessary, in examining the motions, carefully to distinguish the
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the automatic state from the voluntary one, and to remember, that the first is not to be found pure, except in the motions of the new-born infant, or such as are excited by some violent irritation or pain.

COR. 1. The brain, not the spinal marrow, or nerves, is the seat of the soul, as far as it presides over the voluntary motions. For, by *Cor. 2.* of the last *Proposition*, the efficacy of the motory vibrations depends chiefly on that part of them which is excited within the brain.

COR. 2. The hypothesis here proposed is diametrically opposite to that of *Stabl*, and his followers. They suppose all animal motions to be voluntary in their original state, whereas this hypothesis supposes them all to be automatic at first, *i. e.* involuntary, and to become voluntary afterwards by degrees. However, the *Stablians* agree with me concerning the near relation of these two sorts of motion to each other, as also concerning the transition (or rather return, according to my hypothesis) of voluntary motions into involuntary ones, or into those which I call secondarily automatic. As to final causes, which are the chief subject of inquiry amongst the *Stablians*, they are, without doubt, every where consulted, in the structure and functions of the parts; they are also of great use for discovering the efficient ones. But then they ought not to be put in the place of the efficient ones; nor should the search after the efficient be banished from the study of physic, since the power of the physician, such as it is, extends to these alone. Not to mention, that the knowledge of the efficient causes is equally useful for discovering the final, as may appear from many parts of these observations.

COR. 3. It may afford the reader some entertainment, to compare my hypothesis with what *Des Cartes* and *Leibnitz* have advanced, concerning animal motion, and the connection between the soul and body.

body. My general plan bears a near relation to theirs. And it seems not improbable to me, that *Des Cartes* might have had success in the execution of his, as proposed in the beginning of his *Treatise on Man*, had he been furnished with a proper assemblage of facts from anatomy, physiology, pathology, and philosophy in general. Both *Leibnitz's* Pre-established Harmony, and *Malebranche's* System of occasional Causes, are free from that great difficulty of supposing, according to the scholastic system, that the soul, an immaterial substance, exerts and receives a real physical influence upon and from the body, a material substance. And the reader may observe, that the hypothesis here proposed stands clear also of this difficulty. If he admits the simple case of the connection between the soul and body, in respect of sensation, as it is laid down in the first proposition; and only supposes, that there is a change made in the medullary substance, proportional and correspondent to every change in the sensations; the doctrine of vibrations, as here delivered, undertakes to account for all the rest, the origin of our ideas and motions, and the manner in which both the sensations and these are performed.

COR. 4. I will here add Sir *Isaac Newton's* words, concerning sensation and voluntary motion, as they occur at the end of his *Principia*, both because they first led me into this hypothesis, and because they flow from it as a corollary. He affirms then, "both
" that all sensation is performed, and also the limbs
" of animals moved in a voluntary manner, by the
" power and actions of a certain very subtle spirit,
" i. e. by the vibrations of this spirit, propagated
" through the solid capillaments of the nerves from
" the external organs of the senses to the brain, and
" from the brain into the muscles."

COR. 5. It follows from the account here given of the voluntary and semivoluntary motions, that we
must

must get every day voluntary and semivoluntary powers, in respect of our ideas and affections. Now this consequence of the doctrine of association is also agreeable to the fact. Thus we have a voluntary power of attending to an idea for a short time, of recalling one, of recollecting a name, a fact, &c. a semivoluntary one of quickening or restraining affections already in motion, and a most perfectly voluntary one of exciting moral motives, by reading, reflection, &c.

P R O P. XXII.

It follows, from the Hypothesis here proposed, concerning the voluntary Motions, that a Power of obtaining Pleasure, and removing Pain, will be generated early in Children, and increase afterwards every Day.

FOR the motions which are previous and subservient to the obtaining of pleasure, and the removal of pain, will be much more frequent, from the very instant of birth, than those which occasion pain. The number also of the first will be perpetually increasing, of the last decreasing. Both which positions may be evinced by the following arguments.

First, The pleasures are much more numerous than the pains. Hence the motions which are subservient to them are much more numerous also.

Secondly, The associated circumstances of the pleasures are many more in number than the pleasures themselves. But these circumstances, after a sufficient association, will be able to excite the motions subservient to the pleasures, as well as these themselves. And this will greatly augment the methods of obtaining pleasure.

Thirdly, It favours the position here advanced, that the motions subservient to pleasure are of a moderate nature; and therefore, that they can be excited with

with the more ease, both in an automatic and voluntary manner.

Fourthly, The pains, and consequently the motions subservient to them, are few, and of a violent nature. These motions are also various, and therefore cannot be united to objects and ideas with constancy and steadiness; and, which is most to be regarded, they end, at last, from the very make of the body, in that species of motion which contributes most to remove or assuage the pain. This species therefore, since it recurs the most frequently, and continues longest, must be confirmed by association, to the exclusion of the rest.

COR. 1. Many changes in the actions of young children, very difficult to be explained, according to the usual methods of considering human actions, appear to admit of a solution from this proposition. These changes are such as tend to the ease, convenience, pleasure, of the young child; and they are sufficiently observable in the transition of the originally automatic actions into voluntary ones, as matters of fact, whatever be determined concerning their cause. I shall therefore refer to them occasionally, in the course of these papers, as allowed matters of fact.

COR. 2. It seems also, that many very complex propensities and pursuits in adults, by which they seek their own pleasure and happiness, both explicitly and implicitly, may be accounted for, upon the same, or such-like principles.

COR. 3. To similar causes we must also refer that propensity to excite and cherish grateful ideas and affections, and trains of these, which is so observable in all mankind. However, this does not hold in so strict a manner, but that ungrateful trains will present themselves, and recur on many occasions, and particularly whenever there is a morbid, and somewhat painful, state of the medullary substance.

COR. 4. Since God is the source of all good, and consequently must at last appear to be so, *i. e.* be associated with all our pleasures, it seems to follow, even from this proposition, that the idea of God, and of the ways by which his goodness and happiness are made manifest, must, at last, take place of, and absorb all other ideas, and HE himself become, according to the language of the scriptures, *all in all*.

COR. 5. This proposition, and its corollaries, afford some very general, and perhaps new, instances of the coincidence of efficient and final causes.

COR. 6. The agreement of the doctrines of vibrations and association, both with each other, and with so great a variety of the phænomena of the body and mind, may be reckoned a strong argument for their truth.

C H A P. II.

Containing the APPLICATION of the DOCTRINES of VIBRATIONS and ASSOCIATION to each of the SENSATIONS and MOTIONS, in particular.

S E C T. I.

OF THE SENSE OF FEELING.

P R O P. XXIII.

To distinguish the several Kinds of Feeling from each other, and to assign the general Causes of the different Degrees of Exquisiteness in this Sense.

HERE we may first distinguish, feeling into the general and particular.

The general feeling extends to all the parts of the body, external and internal: for they are all susceptible of pain from wounds and inflammations, of being put into a pleasurable state, of numbness, and total want of sensation, and of perceiving heat, cold, and pressure. Some writers consider all the sensations of all the senses as so many kinds of feeling; but I do not here use this word in so extensive an acceptance.

The particular feeling is that more exquisite degree which resides in the insides of the hands, and especially in the ends of the fingers; and by which

we distinguish the tangible qualities of bodies, viz. heat, cold, moisture, dryness, softness, hardness, smoothness, roughness, also their motion, rest, distance, and figure, with more accuracy than by any other part. These sensations are, for the most part, adiaaphorous ones.

The greater exquisiteness of the particular feeling arises probably from the following causes :

First, The sentient *papillæ* rise high from the skin (becoming extreme parts thereby), and receive a large proportional quantity of nerves in the ends of the fingers.

Secondly, The ends of the fingers are themselves extreme parts, and consequently receive stronger agitations in their infinitesimal medullary particles, from the stronger vibrations of the contiguous denser æther. For we must suppose, that the vibrations of the rarer æther within the nerves extend themselves a little way into the denser surrounding æther, and even become stronger to a certain distance ; after which they become weaker again, and are, at last, quite suppressed by the increase of density in the æther, and by their own diffusion.

Thirdly, It is customary, in endeavouring to feel exquisitely, to rub the ends of the fingers against the tangible object. Now this friction may, by exciting vibrations, and a consequent contraction in certain muscular fibrils belonging to the *papillæ*, distend and erect these, and thereby increase their sensibility.

Fourthly, There is much here to be ascribed to practice and habit, *i. e.* to association ; and it is chiefly on this account, that the sensations of the ends of the fingers give us so much more precise information concerning the tangible qualities of bodies, than those of the ends of the toes, since the structure of the nervous *papillæ* is alike in both. It ought to be considered as a part of this reason, that, according to the principles laid down in the last chapter, we

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may get a voluntary power of erecting the *papillæ* without friction, or of increasing and fixing the distention during friction, in order to feel with greater exquisiteness and precision.

The sense of feeling may also be distinguished into that of the external surface of the body, and that of the cavities of the nose, mouth, *fauces*, alimentary duct, *pelvis* of the kidneys, ureters, bladder of urine, gall-bladder, follicles and ducts of the glands, &c. The sensibility in the last is much greater than in the first, because the impressions can more easily penetrate through the soft epithelium, with which the internal cavities are invested, than through the hard cuticle, because the compact fibrous membrane of the true skin does not suffer the vibrations to pass freely up the nerve through its own substance, but rather diffuses them along its surface, and because the moisture of the epithelium dissolves, and thereby renders active, all the saline particles, which touch the internal cavities. In the mouth and nose this sensibility is so great, and attended with such distinguishing circumstances, as to have the names of taste and smell assigned respectively to the sensations impressed upon the *papillæ* of these two organs. And as the sensations of the alimentary duct have a near relation to, and connection with, those of the mouth, I shall refer them to the head of taste. But the sensations of the other internal cavities may be comprehended more properly under feeling.

It ought also to be observed here, that the lips, nipples, and external parts of generation, have a more exquisite sensibility, than the other external parts; partly from the structure of their *papillæ*, and partly from the thinness of the cutis, and softness and thinness of the cuticle. The extreme sensibility of the *cornea* and *tunica conjunctiva* of the eye may arise from the manner in which the nerves are here exposed, and the tension of these parts.

P R O P. XXIV.

To examine how far the Sensations of Heat and Cold are agreeable to the Doctrine of Vibrations.

A BODY is termed *hot*, when its heat exceeds that of the part, with which we touch it; *cold*, when its heat is less than this. The terms *hot* and *cold* are therefore relative ones, and the qualities denoted by them run into each other without any precise distinguishing limits. We may consequently refer *cold* to *heat*, and, if we admit the doctrine of vibrations, we are to suppose, that the small parts of all bodies are agitated by subtle vibrations; and that when these vibrations exceed those of the part with which we touch them, they are called *warm* or *hot*; when they fall short, *cold*.

This may be regarded as a gross, general position, which presents itself upon the first consideration of this matter. But then, as, according to this definition of heat, all those objects of taste and smell, which excite strong vibratory motions in the organs, ought to excite heat, we must inquire farther into the vibratory motions of bodies termed *hot* in common language, and into the difference between these and the vibrations excited in the nerves of taste and smell by sapid and odorous bodies.

I conjecture therefore, that the vibrations belonging to heat are in general quicker and shorter, than the peculiar ones excited by tastes, smells, and colours; also that the last, or the vibrations of the rays of light, are quicker than those of tastes and smells. We may conceive farther, that all the vibrations of the small particles of the medullary substance, and interjacent æther, from whatever cause they arise, grow quicker as they grow shorter, *i. e.* weaker; or, according to

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the conjecture just made, that in declining they tend to those which impress the sensation of heat. For vibratory motions of different lengths can be isochronous only according to one law, viz. that of the accelerating force being in the simple proportion of the distance from the middle point of the vibration, as when a heavy body vibrates in a cycloid; whereas, if the accelerating force be in any less ratio than this, short vibrations will be quicker than long ones. Lastly, we are to conceive, that when two vibrations of different kinds, or frequencies, are impressed at the same time, they must reduce one another to some single intermediate one, unless the quicker be so much more numerous than the slower, as to be comprehended within them, so that both may be performed together without opposition or confusion.

Let us now inquire how far the several effects of heat and cold upon our bodies are agreeable either to the notion of vibrations in general, or to the particular conjectures of the last paragraph.

First, then, We may expect that heat will rarefy the solids and fluids of the body, and the last more than the first, which is agreeable to experience. For the increase of the agitations will make the small particles recede from one another, and that more in fluid than in solid parts, because of their looser texture. There may be other reasons also, drawn from the particular unknown composition of each part, solid and fluid, which may subject them to greater or less rarefaction. Thus I conjecture, that the red blood is more apt to be rarefied than the other fluids, and that it is by this means made a chief instrument in compressing the white medullary substance of the brain, and spinal marrow, in natural and morbid sleep, to both which heat contributes, as has been observed already.

Secondly, If heat be caused by vibrations, we may expect, that those propagated from the hot or cold body should diffuse themselves freely and instantaneously

over the whole nervous system, *i. e.* the whole body; however along the surface of the skin, in an especial manner. This follows from the uniformity both of the whole medullary substance, and of the skin. The first communicates the vibrations which ascend along the nerves affected to the whole body, the last those impressed upon the part of the skin, which touches the hot or cold body, to the other parts of it. Now this is agreeable to experience: for when the whole body is too hot, or too cold, we find that the mere touch of a cold or hot body will give general relief immediately; and in some cases a thrilling or shivering may be felt to run along the skin.

Thirdly, If the skin be contracted by any cause different from the direct impression of cold, as by the pain propagated from a wound, the colic, the irritation of a stone in the bladder, &c. this contraction, first excited by an increase of vibrations in the muscular variously interwoven fibrils of the skin, may be expected afterwards to check and diminish the vibrations there, and thus to occasion the sensation of cold, agreeably to experience. The chilliness arising from matter absorbed, and from the cause of acute distempers, whatever that be, may admit of a like explanation.

The tremors, *i. e.* sudden, short, alternate contractions of the antagonist muscles, which happen in the foregoing cases, arise probably from an increase of vibrations, not subject to ideas, and the voluntary power, descending from the brain into the whole system of the muscles; and seem to differ from the stronger and larger convulsive motions of hysteric and epileptic disorders, called convulsions emphatically, rather in degree than kind. These tremors generally precede the sense of chilliness, when the contraction of the fibrils of the skin does not arise from the direct impression of cold.

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We may from hence pass to the sensation of chilliness, and the tremors, which are sometimes occasioned by the passions, fear, anger, surprize, joy, &c. Both the redness and the paleness of the lips, face, and neck, which are observable in these cases, are marks of a contraction in muscular fibrils; in a less degree in the first case, so as to check the return of the venal blood; in a greater in the last, so as to prevent the influx of the arterial.

Fourthly, It is easy to conceive, that heat may occasion pain, agreeably to the hypothesis concerning pain, above proposed. For the strong vibrations excited by great heat must put the small parts beyond the spheres of each other's attraction, and so produce the solution of continuity. But neither does it seem inconceivable, that cold may have a like effect, agreeably to the doctrine of vibrations, though the process be different. For great cold, by checking the vibrations in the external part, to which it is applied, will alter the situation and distance of the small medullary particles there, and so must excite vigorous vibrations in the ascending nerves, and the corresponding region of the brain, which is just the effect occasioned by heat, applied to the same external part. Hence, if we are touched by a very hot, or a very cold body, inadvertently, and without seeing it, it ought to be difficult to distinguish which it is, agreeably to the fact. The conflict between the diminished vibrations, in the external part to which cold is applied, and the previous ones subsisting in the corresponding part of the brain, may exalt these previous ones, as much as heat does, so as to render the first simple impression of cold similar to that of heat.

Fifthly, The continued impression of heat makes us more sensible of cold. For when heat has rarefied the parts, and adapted them to a peculiar strength and frequency of vibrations, differing from the usual standard, the cold, whose difference from the

the usual standard lies on the other side, must raise a greater conflict, and produce a greater change, than if the parts had remained at the usual standard. The continued impresson of cold must for the same reasons make us more sensible of heat. This explanation will perhaps suit with other theories of sensation, as well as with that drawn from vibrations. However, the mere consistency of any phænomena with the doctrine of vibrations is worthy of some attention in this inquiry.

Sixthly, When the calf of the leg is affected with the cramp, setting the foot upon a cold marble will afford immediate relief. For the cold may check the violent vibrations in the fibres of the *gastrocnemii* and *soleus*, directly and immediately; or it may do it by exciting vigorous vibrations of a different kind, which extend to their antagonist muscles, as well as to the fore-mentioned ones. But I judge the first account to be more probable.

Seventhly, If a limb, that has been much chilled with cold, be brought to a fire suddenly, it will first be much pained, and then mortify. For the vibrations excited by the fire, though moderate in respect of the usual standard, are yet excessive in respect of those which the cold has introduced, also in respect of that sphere of attraction, which it has now fixed upon the parts: there will arise therefore a violent conflict, solution of continuity, and consequent pain; and the parts will be agitated so much more than their present spheres of attraction will permit, that they cannot return to it any more, but must be entirely disunited, and run into different combinations, *i. e.* the limb must mortify. But, if the limb be put into cold water, rubbed, and gradually exalted to the usual standard of heat, it may be preserved. Where it is to be observed, that the heat of water, while fluid, is above the freezing point, and, consequently, greater than that of a frozen limb.

It may somewhat confirm this reasoning, to give a similar explication of some of the phænomena of glass bubbles, made by dropping melted glass into water. We may suppose then, that these fall at once into powder, when broken at their points, because the cold water has so far reduced the sphere of attraction, that all the parts of the bubbles are agitated beyond this, by breaking their points. But if a bubble be heated, and its parts brought to a larger sphere of attraction by the agitations from heat, it will no longer fall to powder when broken at its point. It may also have its parts ground away at pleasure, without falling to powder, because grinding agitates all the contiguous parts with strong vibrations, like heat, and enlarges the sphere of their attractions.

Eighthly, When the parts contiguous to a mortified slough have a sufficient heat in them, excited by the *vis vitæ*, or warm applications, the vibrations attending this life and heat of the parts ought to help to shake off and separate the mortified slough, i. e. to stop the mortification; which is agreeable to the fact. Hence mortifications from external cold, in bodies otherwise healthy, will come to separate soonest, and most perfectly, as it is frequently seen in cold climates. Hence also mortifications happening in the acute distempers of young persons, if they stop at all, stop sooner than those in the extreme parts of old persons.

Ninthly, It is said, that cold water, sprinkled upon the distended limbs of malefactors upon the rack, renews and augments their pains. Now, we may here suppose, that the parts had, in some measure, begun to accommodate themselves to their distended state, by getting new and enlarged spheres of action: when therefore the cold water endeavours to contract the parts again, and to narrow the spheres of action, the limbs still continuing distended by the rack, it is evident,

evident, that a strong conflict, with violent vibrations, and the solution of continuity, must ensue. Was the limb released first, and then cold water applied, it might contribute, as in sprains, to restore the parts to their former state, without exciting any such violent conflict. The good effects of vinegar, verjuice, spirit of wine, and other contracting liquids, in sprains, are to be explained upon the same principles.

Tenthly, Hot or cold water feels hotter or colder, respectively, when the hand is moved in it, than when it is kept at rest. For the hand, when at rest, has time, a little to check or exalt the vibrations in the contiguous hot or cold water.

Eleventhly, When a person goes into cold water leisurely, he is apt to sob, and to respire in a convulsive manner, for a short time. For the impression of the cold upon the lower limbs excites such vigorous vibrations in the abdominal, and other muscles of expiration, as being nearer to the seat of the impression than the muscles of inspiration, that a convulsive continued expiration is first produced, then a sob, or deep inspiration; and lastly, strong convulsive expirations and inspirations for some successions.

The good effects of cold bathing arise perhaps, in part, from its narrowing the sphere of attraction in the small parts of the muscular fibres, and at the same time making this attraction stronger. Hence it may be prejudicial in some paralytical affections, as it is found to be. For, if the small vessels of the nerves be obstructed, it may, by contracting the solids, increase the obstruction, and, consequently, the impediment to the free vibrations necessary to sense and motion.

Twelfthly, Bathing in warm water, impregnated with active mineral particles, may, by exciting and increasing vibrations in the white medullary substance, as well as by other means, remove obstructions in its small

small vessels, and thus be serviceable in many paralytical disorders, as it is found to be in fact. The same reasoning is applicable to the stiffness, insensibility, and impotency, of motion, which the rheumatism often leaves in the limbs.

Cold bathing may in like manner be serviceable in paralytic and rheumatic disorders, by exciting and increasing vibrations; provided the ill effect from the immediate contraction does not preclude this good one.

Thirteenthly, Since frictions, and other impressions upon the skin, increase the vibrations there, it may be expected, that they should increase the heat. And this is the fact. If a person rubs his hands together in cold weather, the sensation of heat will be felt to arise in a moment, and to go off again in a moment after he ceases to rub; for the vibrations excited by rubbing may be expected to languish immediately, if not kept up by continuing the friction.

Fourteenthly, Strong tastes may, according to the doctrine of vibrations, be expected to leave a heat upon the tongue, mouth, and *fauces*, as they are found to do. And, in general, all vivid impressions upon every part of our bodies ought to increase the heat generally or particularly; which perhaps is the case, though we are seldom able to determine this by observation.

Fifteenthly, All strong emotions of mind ought also to increase the heat of the body. This is a matter of common observation, if we except the chilliness of the skin, and coldness of the extremities, which have been explained above, agreeably to the doctrine of vibrations.

The three last articles favour the above delivered conjectures concerning the peculiar nature of the vibrations belonging to heat. The phænomena enumerated in all the fifteen may admit of other explanations, at least in part, but of none, as far as I can judge, that are inconsistent with the doctrine of vibrations.

P R O P.

P R O P. XXV.

To examine how far the Phænomena of Wounds, Burns, Bruises, Lacerations, Inflammations, and Ulcers, are agreeable to the Doctrine of Vibrations.

THE manifest solution of continuity, which is the very essence of a wound, may occasion pain, agreeably to the doctrine of vibrations, in the manner that has been explained already. This is the immediate pain that attends a wound. The subsequent one is to be referred either to the head of inflammation, or to that of ulcer.

The immediate pain from burns has likewise been explained agreeably to the doctrine of vibrations, also the separation of the dead or mortified eschar, under the last proposition. The subsequent pain is to be referred to the heads of inflammation and ulcer, as before.

A bruise is supposed, and with the appearance of reason, to be an infinite number of infinitely small wounds. It ought therefore to be attended with a pain resembling that of a large wound, and yet not exactly the same, which is the fact. As large wounds are sometimes healed by the first intention, without any subsequent ulcer, so may bruises. If otherwise, the subsequent pain must again be referred to the heads of inflammation and ulcer.

Lacerations are great wounds attended with bruises, *i. e.* with an infinite number of infinitely small ones. These are never cured without coming to digestion, *i. e.* an ulcer, and the requisite previous inflammation.

The heat and distention of the small vessels in inflammations are sufficient to account for the pain attending them, upon principles already laid down.

In ulcers the nerves are exposed defenceless, and therefore are susceptible of the most violent vibrations, and consequent pain from slight impressions; to which it is to be added, that the moisture of ulcers, by dissolving the saline parts of bodies applied, greatly augments their actions upon the naked nerves.

Fomentations and cataplasms seem to afford relief in the foregoing cases, partly by diffusing an equal warmth all around, partly by their aqueous or oily moisture. For the diffusion of warmth prevents that conflict, which would arise between neighbouring parts of different heats; and the moisture, which insinuates itself among the small particles, sets them at greater distances, and consequently lessens their mutual actions. The violent vibrations will therefore be moderated on both accounts. The friction attending embrocations does in like manner diffuse vibrations all around, and the liniment or liquid, with which the embrocation is made, may contribute according to its particular qualities. Hence embrocations are also of use in resolving obstructions.

In all these cases the violent vibrations, which ascend along the nerves of the injured part, must be communicated in a particular manner to the neighbouring branches, and occasion a slight inflammation, *i. e.* a soreness, there. This soreness is not perceived while the original inflammation subsists, being obscured by it. The vibrations in the neighbouring nerves may also be increased by the cessation of violent ones in the place of original inflammation. Hence the soreness of the neighbouring parts after colics, head-achs, &c. The pain in the external parts of the head, which follows a debauch, *i. e.* an inflammation of the brain, and its membranes, may be of the same kind.

These hints may serve to shew, that the doctrine of vibrations is as agreeable to the phænomena of wounds, burns, &c. as any other yet proposed, or even more so. But much farther inquiry is requisite.

P R O P.

P R O P. XXVI.

To examine how far the Phenomena of Itching and Titillation are agreeable to the Doctrine of Vibrations.

ITCHING often attends the beginning and ending of inflammations, and particularly the eruption of inflammatory pustules. We may conclude therefore, according to the foregoing account of inflammations, that itching is caused by a moderate increase of vibrations, in a part of small extent.

It is agreeable to this, that the lodgment of the perspirable matter, or other cutaneous secretion, when hardened, occasions itching; for it is easy to conceive, that, in these cases, an obstruction and slight inflammation in the small vessels of the skin may arise.

Pressure, which allays itching, may be supposed to do this by checking the vibrations.

Scratching may convert it into a pleasure, by communicating the increased vibrations to the neighbouring parts, in such a degree as falls within the limits of pleasure. And as this freer communication caused by scratching may increase the vibrations in the neighbouring parts, so it may lessen those which subsisted before in the point that itched, thus reducing all to an equality, or nearly so. At the same time it appears, that rude or long-continued scratching multiplies by the increase of vibrations, which it occasions, also by laceration, increase the heat, inflammation, and itching, and even end in pain.

Friction of the skin, without previous itching, excites a pleasurable sensation; and also ends in inflammation and pain, when carried too far, for the like reasons.

Since extreme parts are more apt to receive an increase of vibrations than others, as has been observed,

it appears, that the itching of the nose and *anus* may be expected to attend worms in the stomach or intestines, and the itching of the *glans penis* and *anus* a slight inflammation at the neck of the bladder from a stone. These instances shew, that vibrations run freely along the surfaces of uniform membranes; and this is farther confirmed in the last case, by the check which a pressure made *in perinaeo*, or any where upon the *urethra*, will give to the itching in the *glans*.

Titillation is nearly related to itching. It is excited by slight impressions upon the more sensible parts, frequently renewed; and this may shew, that it arises from an increase of vibrations. The impressions must be so slight as not to excite a contraction in the neighbouring muscular fibrils, and also frequently renewed, that the increase of vibrations may diffuse itself farther and farther perpetually; and thus the whole nervous system may, in some cases, be at last put into a pleasurable state, approaching to the limits of pain, and passing within them at times.

Hence it appears, that as soon as children have learnt to cry, or yield a sound, from nascent pains, and from pleasures just passing into pains, titillation may excite short, alternate, nascent cries in them, *i. e.* laughter, but not before. If the impressions be made upon the chest, the effect will be quicker and stronger, because these impressions have a direct influence upon the muscles concerned in laughter.

If a feather be passed slightly to and fro between the lips, it will excite a titillation there, which will diffuse itself into the neighbouring parts of the upper lip and chin, and pass into an itching in them. The original titillation between the lips may be allayed by pressing them together, and the consequent itching by pressure and friction, as in other cases. All these things suit with the hypothesis of vibrations, and of their free diffusion.

In like manner, the free diffusion of vibrations, and their influence in contracting the neighbouring muscles, may be inferred from the vomitings, which are excited by tickling the *fauces* with a feather.

P R O P. XXVII.

To examine how far the Sensations attending Pressure, and muscular Contraction, are agreeable to the Doctrine of Vibrations.

As friction and titillation agree with heat in increasing vibrations, so pressure agrees with cold in checking them. Thus pressure abates the uneasiness from itching, as mentioned above; and binding, or otherwise gently compressing, parts in pain, or inflamed, *i. e.* parts in which the vibrations are excessive, will, for the most part, afford relief; whereas friction would increase the pain to a great degree. But the pain usually becomes more violent the instant the compression is removed. For the mere elasticity of the parts alters their figure, *i. e.* produces internal motions, with an increase of vibrations. Pressure may also increase vibrations in the internal parts, contiguous to those where it checks them; or even in the external ones, if it be so great as to occasion any considerable distention there. And thus there may be a variety of vibrations occasioned by the several kinds and degrees of pressure, sufficient to correspond to all the variety of sensations excited thereby.

Muscular contraction most commonly attends and is attended by pressure, as in the common motions of handling and walking, whereby we overcome the *vis inertiae* of our own bodies, and of those which we have occasion to move or stop. Hence all the sensations, which we receive from the *vis inertiae* of matter

matter, must be derived from these two sources of muscular contraction and pressure.

Now it has been observed already, that muscular contraction checks the vibrations in the contracted fibres, and increases them in the neighbouring parts. And it is easy to conceive, that the sensation corresponding to this alteration of vibrations may sometimes fall within the limits of pleasure, sometimes go beyond them. In young animals, also after sleep and rest, in all, it is usually pleasant; after much labour, or sprains, and in inflammations, painful; and this, whether the disordered muscle itself, or its antagonist, be contracted. For there must be an increase of vibrations in the disordered muscle both before it can be itself contracted, and also in consequence of the contraction of its antagonist; as has been shewn before.

P R O P. XXVIII.

To examine how far the Phenomena of Numbnesses, and paralytical Insensibilities, are agreeable to the Doctrine of Vibrations.

NUMBNESS, being a diminution of sensibility, ought, according to the doctrine of vibrations, to proceed from such causes, as either indispose the parts for the reception of vivid vibrations, or hinder their free ascent to the brain. Agreeably to this, a compression made upon the nerve, which leads to any part, will occasion a numbness in that part, the nerve below the compression being unfitted thereby to receive vibrations freely, and the nerve above incapable of transmitting freely such as are excited. A compression of a blood vessel may have alike effect, because it must lessen that heat, and intestine motion, which a free circulation would communicate to the part. The compression usually made upon the skin, when we press a nerve or blood vessel, will

also contribute. And external cold will hasten the effect, when joined to the just named causes; or produce it alone, if intense, or long continued. In like manner, numbness, from a compression made upon the nerves or blood vessels, is much favoured by sleep, because the parts are then indisposed both to receive and to transmit vibrations.

The benumbed limb feels larger, because any gross body, which encompasses and presses upon a limb by its weight or stricture, deadens the vibrations in it; and therefore conversely, when the vibrations are so deadened from a different cause, the idea of a gross encompassing body, or, which is almost the same thing, of the enlargement of the limb, will be suggested to the mind. But this circumstance must be referred to the head of association.

When the benumbed part begins to recover its feeling, violent prickings are often perceived. Now these seem to take place in the points where the natural vibrations first return, suppose at the ends of the nervous *papillæ*, and to arise from the conflict between the natural vibrations in these points, and the languid ones in the neighbouring parts. However, they come to an equality at last, by their mutual influences, as well as by the return of the natural vibrations to all the parts; which may serve to shew how itching ceases at last of itself. Friction helps to disperse and remove these prickings, and to restore the lost sensibility, which is very suitable to the notion of vibrations, and to the effect which it has in itchings.

If the hand be held down, and shaken, its muscles being first relaxed by a voluntary power, a numbness will be occasioned, in which the fingers feel large, for the reason given above. This numbness seems to arise from the irregular agitations, or vibrations, excited in the small parts; which, being different from the natural ones, or those in which sensibility consists,

consists, must check them; just as the agitations of water from the wind hinders the free propagation of regular undulations from a stone cast into it; or as any commotion of the air checks the free and distinct communication of a sound. It seems also, that those irregular and dissonant vibrations, which shaking the hand causes in the small medullary particles of its nerves, may pass on from part to part, though not so freely as regular ones.

From hence we may proceed to consider the numbness occasioned by the stroke of the *torpedo*. For the oscillations of this fish's back may neither be isochronous in themselves, nor suitable to those which existed previously in the hand; and yet they may be so strong, as not only to check and overpower those in the part which touches the fish, but also to propagate themselves along the skin, and up the nerves, to the brachial ganglion, and even to the spinal marrow and brain; whence the person would first feel the stupefaction ascend along the arm to the shoulder, and then fall into a giddiness, and general confusion, as is affirmed to happen sometimes. Some effects of concussions of the brain, and perhaps of the spinal marrow, also of being tossed in a ship, of riding backwards in a coach, and of other violent and unusual agitations of the body, seem to bear a relation to the present subject. But it would be too minute to pursue these things.

When a palsy arises from an internal cause, we may suppose, that the medullary part of the brain, or of the spinal marrow, or the nerve itself, in all which the vessels are extremely fine, and therefore liable to obstructions, especially in old age, become opaque, and unqualified to receive and transmit vibrations freely, according to Sir *Isaac Newton's* opinion. Hence a diminution or entire loss of sense or motion, or both, may follow, according to the degree and extent of the obstruction and opacity. The voluntary

power of motion is soon lost, as being an acquired faculty, and depending upon associated circumstances, and memory. But if there be any degree of inflammation in the fine vessels of the motory nerves, or of the corresponding parts of the brain, this may occasion convulsive motions; and for the same reason, an inflammation in the sensory nerves, or their origins in the brain, may occasion pain. Now it is reasonable to expect such inflammations in many cases as a consequence of the obstructions, and both convulsive motions and pains are often found to attend paralytic affections.

P R O P. XXIX.

To examine how far the Phænomena attending on venomous Bites and Stings are agreeable to the Doctrine of Vibrations.

THAT the active liquors, infused by venomous animals after they bite or sting, operate, in part, by the violent vibrations which they excite in the living parts immediately affected, and which are thence propagated along the nerves up to the brain, and also along the surface of the body, by means of the continuity and uniformity of the skin, may appear from the following reasons.

First, As the solids and fluids, seem in general, equally concerned in all the natural functions, and morbid deviations from them, it is most reasonable to refer part of the effects of venomous bites and stings to each. But it is difficult to conceive how these poisons should have any immediate effect upon the solid nervous capillaments, but by agitating their parts.

Secondly, The active particles of these poisons, which are able, in so small a quantity, to produce such violent disorders, and sometimes in a very short space of time, may well be conceived able also to agitate the nervous parts with strong vibrations.

Thirdly,

Thirdly, If we suppose their first and most immediate effect to be upon the fluids, yet this may, or must, be agitations, that will afterwards be communicated to the solids.

Fourthly, The vibrations of the medullary particles, mentioned in this theory, seem peculiarly suited to answer the several quick and surprizing effects of these poisons. The pain, swelling, redness, and lividness, all around the part affected, may easily be derived from the vibrations propagated all around. Oils and fats, rubbed upon the part, may, by damping these, prevent the ill effects. Vibrations, propagated either along the skin, through the mouth and nose, or up to the brain, and thence along the eighth pair of nerves, or, which is most probable, both ways, to that very sensible part the stomach, may produce sickness and vomitings. And if the gall-duct be contracted from the same cause during the vomitings, a sudden jaundice will follow from the violence with which the gall is forced back into the blood by the action of vomiting. Joy, sorrow, fear, melancholy, may easily follow according to the respective natures of the poisons, because these, according to this theory, all arise from and are attended by corresponding vibrations in the white medullary substance of the brain. And a like account may be given of the aversion to black, and the delight in glaring objects, and strong colours. The corresponding nerves of different animals have probably a general resemblance to each other, just as the corresponding *viscera* and fluids have. And thus the poison of rabid animals may have a peculiar power of affecting the nerves of the *fauces*, and muscles of deglutition, so as to produce the *hydrophobia*. Cold bathing also, and music, whose immediate effects seem confined to the solids, to the exciting vibrations in them, may cure respectively in the bite of a mad dog, and of the tarantula.

However, what is here alleged is not at all to be so understood, as if the immediate effects of poisons upon the fluids were not also very considerable. In some cases they may be greater, in others less, than those exerted upon the solids. It seems probable, that the poison is communicated from the fluids immediately affected to those at a distance, chiefly by means of the serous vessels. For these, having numerous immediate communications with each other, will transmit it freely, and yet so as that all the neighbouring parts may be affected somewhat in proportion to their nearness to the seat of the injury, as they are found in fact to be; whereas, were the diffusion of the poison to be made by the circulation of the fluids alone, all the parts would have an equal chance. But the propagation of the poison along the solid capillaments of the nerves is also a principal reason why the neighbouring parts are more affected than the distant ones. The effects of inoculation bear a great resemblance to those of venomous bites and stings; and the same may be said of venereal and other infections.

P R O P. XXX.

To examine how far the tangible Qualities of Bodies admit of an Explanation agreeable to the Doctrine of Vibrations.

HITHERTO we have considered only the more vigorous sensations of feeling, such as may be called the pleasures and pains of this sense. We come now to the feeble and adiaphorous sensations. These are moisture, dryness, softness, with fluidity, hardness, smoothness, roughness, motion, rest, distance, and figure. Now it seems very easy to conceive, that these, with their several varieties, may impress corresponding varieties, of vibrations upon the nerves
of

of feeling; also, that these last varieties will be chiefly compositions of the vibrations arising from pressure, and muscular contraction, *i. e.* from the *vis inertiae* of matter.

Thus, since moist bodies adhere to the fingers, and so leave a smoothness with their own degree of cold or heat upon them, moisture may be judged of by the touch from this peculiar alteration of vibrations; and dryness from the absence of it. Liquid bodies make no alteration of figure in our fingers, and yield easily to their motions: soft ones do the same in a less degree; hard ones the contrary. Smooth bodies make an equable pressure, and give no resistance to a motion along their surfaces; rough ones the contrary. The motions of our own bodies are attended by the vibrations peculiar to pressure, and muscular contraction; of other bodies, which touch our own, by those from pressure. We judge of rest by the absence of these. Distance is judged of by the quantity of motion, and figure by the relative quantity of distance. And thus it appears, that all degrees and kinds of these tangible qualities may impress corresponding vibrations upon those regions of white medullary substance of the brain, and spinal marrow, which correspond to the skin and muscles.

The same qualities are made also by means of light to impress vibrations upon our eyes, which correspond in great measure to those made on the sense of feeling, so as to vary with their varieties. And as the sense of sight is much more extensive and expedite than feeling, we judge of tangible qualities chiefly by sight; which therefore may be considered, agreeably to Bishop *Berkley's* remark, as a philosophical language for the ideas of feeling; being, for the most part, an adequate representative of them, and a language common to all mankind, and in which they all agree very nearly, after a moderate degree of experience.

However,

However, if the informations from touch and sight disagree at any time, we are always to depend upon touch, as that which, according to the usual ways of speaking on these subjects, is the true representation of the essential properties, *i. e.* as the earnest and preface what other tangible impressions the body under consideration will make upon our feeling in other circumstances; also what changes it will produce in other bodies; of which again we are to determine by our feeling, if the visual language should not happen to correspond to it exactly. And it is from this difference that we call the touch the reality, light the representative: also that a person born blind may foretell with certainty, from his present tangible impressions, what others would follow upon varying the circumstances; whereas if we could suppose a person to be born without feeling, and to arrive at man's estate, he could not from his present visible impressions judge what others would follow upon varying the circumstances. Thus the picture of a knife, drawn so well as to deceive his eye, would not when applied to another body, produce the same change of visible impressions, as a real knife does, when it separates the parts of the body through which it passes. But the touch is not liable to these deceptions. As it is therefore the fundamental source of information in respect of the essential properties of matter, it may be considered as our first and principal key to the knowledge of the external world.

P R O P. XXXI.

To explain in what Manner we are enabled to judge of the Seat of Impressions made on the external Surface of our Bodies.

WHEN we apply the parts of our bodies to each other, particularly our hands to the several parts of the surface of our bodies, we excite vibrations in both

both parts, viz. both in the hands, and in that part of the surface which we touch. Suppose the hand to pass over the surface gradually, and the first impression will remain the same, while the last alters perpetually, because the vibrations belonging to the last are excited in different nerves, and by consequence enter the brain, or spinal marrow, at different parts. And this difference in the last impression, or its vibrations, corresponding always to the part on which the impression is made, will at last enable us to determine immediately what part of our bodies we touch; *i. e.* what is the distance of the part touched from the mouth, nose, shoulder, elbow, or other remarkable part, considered as a fixed point.

For by passing frequently from the mouth, nose, &c. to the part under consideration, children learn this very early, even without attending to it at all explicitly.

Sight also helps us to judge of this distance in the parts, which are frequently exposed to view, and this in proportion to that frequency.

Let us suppose then, that we are able to determine at once what external part of our bodies we touch, *i. e.* to determine how it is situated in respect of the other parts, and to shew the corresponding part in the body of another person; it will follow, that if a like impression be made not by our own hand, but by that of another, or by any foreign body, we shall know at once the part on which it is made. We shall also, supposing us arrived at a sufficient degree of voluntary power over the muscles, be able at once to put our hand upon the part on which the impression is made.

By degrees we shall learn to distinguish the part, not only when an impression like the gentle ones of our hands is made upon it, but also when a vivid, rude, or painful one is. For, first, all impressions made upon the same part agree in this, whatever be their differences as to kind and degree, that they enter by the same nerves, and at the same part of the brain, and
spinal

spinal marrow. Secondly, we impress a great variety of sensations ourselves by our hands, according as they are hot or cold, by friction, scratching, &c. and most impressions from foreign bodies will bear some resemblance to some of these. Thirdly, we often see upon what part impressions from foreign bodies are made. Fourthly, when they leave permanent effects, as in wounds, burns, &c. we always examine by feeling, where the impression was made.

Now from all these things laid together it follows, that in itchings from an internal cause, and in impressions where neither our hand nor eye give us any information, we shall, however, be able to determine at once with tolerable accuracy what external part is affected, and to put our hand upon it, so as to confirm our present judgment, and render our future judgment, and voluntary power, more certain and ready. We shall also do this most readily in those parts which we see and feel most frequently, the hands for instance; less so, *ceteris paribus*, in those we seldom see or feel; and least so, where we never see the part, and seldom touch it. At least this seems to result from the theory. But it is to be observed, that the fact ought to be tried chiefly in children. For in adults the several degrees approach more to perfection, *i. e.* to an equality among themselves.

P R O P. XXXII.

To explain in what Manner, and to what Degree, we are enabled to judge of the Seat of internal Pains.

HERE we may observe, first, that as we never see or feel the internal parts, such as the lungs, heart, stomach, intestines, liver, kidneys, bladder, &c. we can have no direct information in the manner explained under the foregoing proposition.

Secondly,

Secondly, Since all pains diffuse an increase of vibrations into the neighbouring parts, the increased vibrations in the external parts, arising from internal pains, will be a gross general direction, so as to determine the seat of the pain within gross limits, in respect of superior and inferior, anterior and posterior, right and left.

Thirdly, Pressing the external parts, so as to augment or alleviate the internal pain, must contribute also.

Fourthly, Since all the internal parts in the *thorax* and *abdomen* receive branches from the intercostal nerve, which communicates with each vertebral pair, it follows that the internal pains will send vibrations up to the spinal marrow, which will enter in at the same parts of it, as the vibrations from external pains in the neighbourhood. At the same time it appears from the many ganglions, plexuses, and communications of nerves in the *thorax* and *abdomen*, also from the origin and distribution of the nerves of the *cauda equina*, that this can be no more than a gross general direction; and that the great number of sympathetic influences from these causes, also from the running of vibrations along membranes, and from their fixing particularly in nervous parts, or extreme ones, will give occasion to many deceptions here, and in certain cases make the pain be felt, *i. e.* appear to be, in parts at a considerable distance from the seat of the disorder.

Fifthly, Suppose the patient to shew by the external parts whereabouts his pain is felt internally, then the physician may, from his knowledge of the situation of the internal parts in respect of the external, guess pretty nearly, what internal part is affected.

Sixthly, The symptoms attending the pain, its cause and consequences, compared with the natural functions of the parts, with the history of diseases, and morbid dissections, will enable the physician to determine with great precision in some cases, and help a little in most.

Seventhly,

Seventhly, When the patient has had long experience of the same kind of internal pains, or of different ones, he describes more exactly, and also gets certain fixed points, to which he refers his pains.

Eighthly, Anatomists and physicians may sometimes judge with great exactness in their own cases, having both a knowledge of the parts, and their functions, and also their own feelings, to guide them.

This subject deserves a particular and accurate examination, it being of great consequence to be able to discover the seat and *causa proxima* of the distemper, from the complaints of the patient, and from the previous concomitant, and consequent circumstances. I hope these two propositions may cast some light upon it.

Here we may add an observation deducible from the doctrine of association, viz. as we learn by degrees, from impressions made on the surfaces of our bodies, to attend particularly to the sensations impressed on, or existing in each part, at pleasure, *i. e.* to magnify the vibrations which take place in it; so, after disorders in the internal parts, the associated circumstances seem often to renew the painful vibrations there, and to occasion either the return of the like disorder, or some other; at least to have a considerable share in these effects, when produced by their causes in an inferior degree. Thus disorders in the bowels, caused at first by acrid impressions lay the foundation for a return of like disorders on less occasions. Thus women that have often miscarried, seem to irritate the muscular fibres of the *uterus* by the recollection of the associated circumstances, and so to dispose themselves to miscarry more than according to the mere bodily tendency; fear and concern having also a great influence here. All this will be farther illustrated by what follows under the next proposition.

P R O P.

P R O P. XXXIII.

To explain in what Manner, and to what Degree, the Pleasures and Pains of Feeling contribute, according to the Doctrine of Association, to the Formation of our intellectual Pleasures and Pains.

It follows from the foregoing account of the power of leaving traces, and of association, that all the pains from intense heat and cold, wounds, inflammations, &c. will leave a disposition in the nervous system to run into miniature vibrations of the same kind, and that these miniature vibrations will be excited chiefly by the associated circumstances. That is to say, The appearance of the fire, or of a knife, especially in circumstances like to those in which the child was burnt or cut, will raise up in the child's nervous system painful vibrations of the same kind with, but less in degree than, those which the actual burn or wound occasioned.

By degrees these miniature pains will be transferred upon the words, and other symbols, which denote these and such-like objects and circumstances: however, as the diffusion is greater, the pain transferred from a single cause must become less. But then, since a great variety of particular miniatures are transferred upon each word, since also the words expressing the several pains of feeling affect each other by various associations, and each of them transfers a miniature of its own miniature upon more general words, &c. it comes to pass at last, that the various verbal and other symbols of the pains of feeling, also of other pains bodily and mental, excite a compound vibration formed from a variety of miniatures, which exceeds ordinary actual pains in strength. These compound vibrations will also have a general resemblance, and particular differences in respect of each other.

It

It follows therefore *a priori*, as one may say, and by a synthetic kind of demonstration, that, admitting the powers of leaving traces, and of association, compound or mental pains will arise from simple bodily ones by means of words, symbols, and associated circumstances. And they seem to me to answer in kind and degree to the facts in general. If, farther, we admit the doctrine of vibrations, then these compound mental pains will arise from, or be attended by, violent vibrations in the nervous system, and particularly in the brain.

Agreeably to this account, we may observe, that the mere words denoting bodily pains, though not formed into propositions or threatenings, affect children. However, since there happen daily associations of the mere words with freedom and security, and of propositions and threatenings with sufferings, children learn by degrees to confine their fear, sorrow, &c. to those things which are esteemed the genuine signs, reasons, causes, &c. of sufferings. This is the case in general; but there are great particular differences both in children and adults; which yet, if accurately pursued, would probably not only be consistent with, but even confirm and illustrate, the doctrine of association.

And we may conclude upon the whole, since the pains of feeling are far more numerous and violent than those of all the other senses put together, that the greatest part of our intellectual pains are deducible from them.

In like manner the pleasures of an agreeable warmth, and refreshing coolness, when we are cold or hot respectively, of gentle friction and titillation, leave traces of themselves, which by association are made to depend upon words, and other symbols. But these pleasures, being faint and rare in comparison of others, particularly of those of taste, have but a small share in forming the intellectual pleasures. Titillation may perhaps be excepted. For laughter, which arises from it, is a principal pleasure in young children, and

and a principal source of the other pleasures, particularly of those of sociality, and benevolence. Farther, since the miniatures left by the pains of feeling must in some cases be faint originally, in others decline from the diffusion, the faintness of the association, &c. these miniature pains will often fall within the limits of pleasure, and consequently become sources of intellectual pleasure; as in recollecting certain pains, in seeing battles, storms, wild beasts, or their pictures, or reading descriptions of them.

P R O P. XXXIV.

To give an Account of the Ideas generated by tangible Impressions.

HERE it may be observed, first, that the very words, *burn, wound, &c.* seem even in adults, though not formed into propositions, or heightened by a conjunction of circumstances, to excite, for the most part, a perception of the disagreeable kind; however, so faint in degree, that it may be reckoned amongst the number of ideas, agreeably to the definitions given in the introduction.

Secondly, The words expressing the pleasures of this sense are probably attended with perceptions, though still fainter in degree. These perceptions may therefore be called the ideas belonging to those words.

Thirdly, The words *moist, dry, soft, hard, smooth, rough,* can scarce be attended with any distinguishable vibrations in the fingers, or parts of the brain corresponding thereto, on account of the faintness of the original impressions, and the great varieties of them; however, analogy leads us to think, that something of this kind must happen in a low degree. But when the qualities themselves are felt, and the appropriated vibrations raised, they lead by association to the words expressing them; and thus we can distinguish.

guish the several tangible qualities from each other by the differences of their vibrations, and declare in words what each is.

Fourthly, The vibrations excited in the sense of feeling by motion, distance, and figure, are so faint, and so various, that neither these words, nor any related expressions, can be supposed to excite any miniature vibrations in this sense. Yet still, upon feeling motions and figures, and passing over distances, the differences of vibrations from pressure and muscular contraction, *i. e.* from the *vis inertiae* of our own bodies, or of foreign matter, suggest to us the words expressing these, with their varieties, by association.

Fifthly, The great extent of the sense of feeling tends to make the miniatures fainter, especially as far as the external parts are concerned; and would probably have so powerful an effect upon the miniatures raised in the internal parts, as to make them by opposing destroy one another, did not all the impressions of the same nature, *viz.* all those from heat, from cold, from friction, &c. by whatever external part they enter, produce nearly the same effect upon the brain. Whence the several miniatures left by particular impressions of the same kind must strengthen one another in the internal parts, at the same time that they obliterate one another in the external ones. However, where a person has suffered much by a particular wound, ulcer, &c. it seems according to the theory, that an idea of it should be left in the part affected, or corresponding region of the brain, or spinal marrow.

Sixthly, The visible ideas of the bodies which impress the several sensations of feeling upon us, are, like all other visible ones, so vivid and definite, that they mix themselves with, and somewhat obscure, the most vivid ideas of feeling, and quite overpower the faint ones. Sight communicates to us at once the size, shape, and colour of objects; feeling cannot do the last at all, and the two first only in a tedious way; and

is scarce ever employed for that purpose by those who see. Hence persons born blind must have far more vivid and definite ideas of feeling than others. An inquiry into their real experiences would greatly contribute to correct, illustrate, and improve, the theory of ideas, and their associations.

P R O P. XXXV.

To explain the automatic Motions, which arise from tangible Impressions.

THE principal of these is the action of crying, which is in all animals, but especially young ones, the natural and necessary consequence of pain. I have already given some account of this action; but will here enter into a more particular detail of the circumstances, and their agreement with the foregoing theory.

Let us suppose then a young child to have a very painful impression made upon the skin, as by a burn. It is plain that the violent vibrations excited in the injured part, will pass up to the brain, and over the whole muscular system, immediately; putting all the muscles into a state of contraction, as much as may be, *i. e.* making the strongest set of muscles every where overpower the weaker, for a certain time, and then give place to them for a certain other time, and so on alternately. Since therefore the muscles of expiration are stronger than those of inspiration, the air will be forced strongly out of the *thorax* through the *larynx*, and, by consequence, yield a sound. It contributes to this, that the muscles of the *os hyoides* and *larynx*, acting all together, and drawing different ways, must suspend the cartilages of the *larynx*, so as both to narrow the passage of the air, and also render these cartilages more susceptible of vibrations. As to the muscles which contract and dilate the *larynx*,

they are perhaps about equal in strength to each other, and therefore may, by opposing each other, keep the chink in a state intermediate between its least and greatest dilatation.

That the strongest set of antagonist muscles overpower the weaker, during the great effort in crying, may farther appear from the action of the extensors of the neck, and flexors of the hand (both which sets are stronger than their antagonists), at that time.

If it be objected here, that the elevators of the lower jaw, being stronger than the depressors, ought to keep the mouth shut during the action of crying, according to the foregoing reasoning, whereas the contrary always happens; I answer, first, that when both these sets of muscles act at the same time, in proportion to their natural strength, the mouth ought to be a little opened; secondly, that the vibrations which take place in the cartilages of the *larynx* seem to impart a peculiar degree of force to all the neighbouring muscles, *i. e.* to the depressors of the lower jaw; and, thirdly, that the muscles which pass from the *larynx* and *os hyoides* to the lower jaw act to an advantage in drawing it down, in the present case, because the *os hyoides* is at this time fixed by its other muscles.

The distortions of the face, which happen previously to crying, and during the course of it, seem to be sufficiently agreeable to the notions here advanced; the muscles, which draw the lips from each other, being much stronger, than those which close them.

The manner in which titillation occasions laughter in its automatic state, has been already explained. We may add here, that touching the cheeks of young children gently will excite smiling.

Friction also occasions many automatic motions in young children, as may be observed when their naked bodies, or hairy scalps, are rubbed by the nurse's

nurse's hand ; the motion being determined in these cases, as appears, by the strength and vicinity of the muscles.

The contraction of the hand in young children, which has been taken notice of already, may be excited by titillation, friction, and almost any impression on the palm ; and is to be deduced partly from the superior strength of the flexors here, partly from the exquisite sensibility of the palm. The contraction of the foot from impressions made on the sole is analogous to that of the hand.

It may not perhaps be amiss to add here, that the cellular substance intervenes less between the skin and subjacent muscles in the scalp, palm, and sole, than in other parts, as appears both from anatomical inspection and emphysemas ; and that this may increase the influence of the impressions on these parts over the subjacent muscles.

P R O P. XXXVI.

To explain the Manner, in which the automatic Motions, mentioned in the last Proposition, are converted into voluntary and semivoluntary ones.

THIS has been done, in some measure, already, in respect of the actions of crying, and contracting the hand, and their derivatives, speaking and handling ; and will be done more completely hereafter in a proposition appropriated to the distinct consideration of the motions that are perfectly voluntary. I have therefore inserted the present proposition chiefly for the sake of regularity, and that the reader might have in one short view, from the propositions of this section, all the principal heads of inquiry relating to the sense of feeling.

It may not, however, be improper here to observe, that the great variety of frictions, flexures, and positions, which nurses give to young children, make a proportional variety of combinations of muscles which act together; and that these, by opposing the natural ones from juxtaposition, derivation of nerves, &c. to a certain degree, prepare the way for such voluntary combinations, as are requisite in the future incidents of life.

S E C T. II.

OF THE SENSE OF TASTE.

P R O P. XXXVII.

To assign the Extent of the Organ of Taste, and to explain, in general, the different Powers lodged in the different Parts of it.

THE taste may be distinguished into two kinds, as before observed of feeling, viz. the particular exquisite one, which resides in the tongue, and especially in the tip of it; and the general one, which extends itself to the insides of the lips and cheeks, to the palate, *fauces*, *oesophagus*, stomach, and whole alimentary duct, quite down to the *anus*; the sensibility growing perhaps less and less, perpetually, in going from the stomach to the *rectum*. The sensibility of the alimentary duct is probably of the same kind with, and not much greater in degree than, that of the internal surfaces of the gall-bladder, urinary-bladder, *pelvis*, ureters, and, in general, of the secretory and excretory vessels, and of the receptacles belonging to the glands. But I refer the sensations of this duct to the taste, on account of their connection with those of the tongue, in respect of their causes, uses, and effects.

As to the particular and superior powers of the tongue, they may, in part, be deduced from the number and largeness of its *papillæ*, and from their rising above the surface in living persons more remarkably than any other sentient *papillæ* in the whole body, so as to be extreme parts in an eminent degree. To which we ought perhaps to add, that the tip and sides, in which the taste is most exquisite, are also

extreme parts. But there may be likewise a different peculiar distribution, and other causes of an exquisite sensibility, in the nerves of the tongue.

It deserves notice here, that the friction of the tongue against the palate is necessary, in order to excite the tastes of the aliments, which we masticate, in perfection. This practice is analogous to that of rubbing the ends of the fingers upon such bodies as we examine accurately by feeling; and both appear suitable to the notion of vibrations; also to that of the distention and erection of the sentient *papilla*: which may even be seen in the *papillæ* of the tongue.

It has been observed, that bitters and acids applied to funguses of the brain, and even to issues upon the *vertex*, have sometimes occasioned the sensations of the tastes respectively arising from the same bitters and acids, when applied to the tongue. This may perhaps be solved by supposing, that the bitters and acids, when applied to the nerves of the fifth pair, in the funguses of the brain, and to those of the seventh, or perhaps of the fifth also, in the issues (for the fifth pair may transmit some branches to the external integuments from the *dura mater*, at the *vertex*), send up their own specific vibrations into those regions of the brain, which are the peculiar residence of tastes, *i. e.* to the regions which correspond to the fifth pair, according to some anatomists. And these sensations may even afford some evidence, that the fifth pair, not the ninth, supplies the tongue with sensory nerves.

P R O P. XXXVIII.

To examine how far the Phenomena of Tastes, and their specific Differences, are suitable to the Doctrine of Vibrations.

HERE I observe, first, that heating any sapid liquid increases its taste, especially if it be of the bitter, spirituous, or acrid kind; and, conversely, that the impression of such tastes generates a heat in the organ, which remains after the peculiar taste ceases. Now this connection of certain tastes with heat is some presumption, that they arise from vibrations, provided we allow heat to arise from them, according to the common opinion.

Secondly, Since disagreeable tastes must, according to the account of pain given above, arise from such a violence in the vibrations excited, as produce the solution of continuity, and pleasant tastes, from more moderate degrees of vibrations, which, though they approach to the solution of continuity, yet fall short of it; the pains of taste must proceed from stronger vibrations than the pleasures. And, agreeably to this, bodies which impress very active and disagreeable tastes, manifest great activity in other trials, for the most part.

Thirdly, It is very difficult to give any plausible account of the great variety of pleasant and unpleasant tastes from the doctrine of vibrations. However, the different frequency of vibrations, which belongs to the small particles of different sapid bodies, may be, in a good measure, the source of this great variety. For if the particles of the body *A* oscillate twice, while those of the body *B* oscillate only once, the sensations excited by them may be different, though both fall within the limits of pleasure, or both pass into those of pain. The differences of degree

degree may also contribute ; for it is observable, that different disagreeable tastes, in declining, leave agreeable ones, which approach to each other. This I have experienced in aloes, lime, and green tea not sweetened. It may therefore be, that the different disagreeable tastes were such rather on account of degree than kind. And, upon the whole, it may be, that the several combinations of the differences of kind with those of degree may be sufficient in number to account for all the varieties and specific differences of tastes.

Fourthly, Tastes appear to be more different than they are from the odours which accompany some of them. And this observation, by reducing the number of tastes properly so called, does somewhat lessen the difficulty of accounting for their number. But then it is also to be observed, that part of this difficulty is to be transferred to the head of odours.

Fifthly, The power of distinguishing tastes seems to depend upon sight, to a certain degree. And this consideration also lessens the number of tastes properly so called.

Sixthly, If we suppose the sapid body to consist of particles, that excite vibrations of different frequencies, which may be the case of many bodies in their natural state, and probably must be with such as are compounded by art, compound medicines for instance, a great variety of tastes may arise, some resembling the tastes of simple bodies, others totally unlike these: just as some of the colours reflected by natural and artificial bodies resemble one or other of the simple primary ones, whilst others are colours that can scarce be referred to any of these. And we may farther suppose, in both cases, that where the vibrations approach so near, in frequency as to over-rule each other, and produce one species only, there results a taste, or a colour, that resembles a primary one ; whereas, if the vibrations differ so much in frequency,

quency, as that two or more principal specieses keep their own frequency, the taste, or colour, generated from them, cannot be likened to any primary one.

Seventhly, That there are different specieses of vibrations, which yet all constitute sweet or bitter, I conjecture not only from the foregoing general reasoning, but also because there are both sweets and bitters in all the three kingdoms, animal, vegetable, and mineral. Thus milk, sugar, and *saccharum saturni*, all yield a sweet taste; gall, aloes, and crystals of silver, all a bitter one.

Eighthly, Some differences of taste may arise from the different time required for the solution, and consequent activity, of the sapid particles, also from the different local effect which they may have upon the *papilla*, when absorbed by their venous vessels, &c.

Ninthly, Very nauseous and stupefacient tastes may perhaps arise from violent and irregular vibrations, and bear some analogy to the sensation, or want of it, impressed by the stroke of the *torpedo*.

Tenthly, It seems to deserve particular consideration here, that milk, and the flesh of certain domestic animals, yield tastes, which are naturally and originally pleasant, to a considerable degree, and yet not in excess, as sugar, and other very sweet bodies, are. For it is reasonable to conclude, that the particles of milk, and common flesh-meats, must agree very much in the strength and frequency of vibrations with the particles of our own solids and fluids. They may therefore just moderately increase the natural vibrations of the organ, when applied thereto, and enforced by suction, mastication, and friction of the tongue against the palate. For the same reasons we may guess, that the common diet of animals does not undergo very great changes, in respect of the vibratory motions of its particles, from its circulation, and consequent assimilation. However, there

there are some eminent instances to the contrary, especially in poisons. These last observations may be extended to vegetables, salutary and poisonous respectively.

Eleventhly, Some acrid tastes, that of mustard for instance, affect the tip of the *uvula*, and the edge of the soft palate, in a particular manner. Now this may a little confirm the conjectures above made concerning the sensibility and irritability of extreme parts.

Twelfthly, It is easy to conceive, upon the principles of these papers, how sweets and bitters of an inferior degree should render those of a superior one less affecting, respectively, as they are found to do.

The foregoing articles are only imperfect conjectures, and do not even approach to a satisfactory solution. They may just serve to shew, that the doctrine of vibrations is as suitable to the phænomena of tastes, as any other hypothesis yet proposed. The following methods may perhaps be of some use for the analysis of tastes.

First, To make trials upon bodies whose particles seem similar to each other. Such are perhaps distilled spirits, acid, alkaline, and fermented; also salts, and oils; but they must all be sufficiently purified by repeated distillations, solutions, and such-like chemical operations; else we are sure, that their component particles are heterogeneous.

Secondly, To note the changes of taste in chemical operations, and compare them with the changes of colour; which last, by discovering the sizes of the particles, may determine many things relating to their mutual actions. The solutions of metals in acids, by affording many singular and vivid tastes, and sometimes colours, seem to deserve especial notice here.

Thirdly, There are many regular changes in natural bodies, which, by comparison with other phænomena,

nomena,

nomena, may be of use. Thus it is remarkable, that the juice of many or most fruits is first acid, *i. e.* whilst unripe, then sweet, then vinous, after the first fermentation, then acid again, after the second fermentation.

This inquiry is of great importance in medicine and philosophy. And the theory of tastes appears capable of becoming a principal guide in discovering the mutual actions of the small particles of bodies. The difficulty is to make a beginning. This theory may not perhaps be more complex than that of colours; one may, at least, affirm, that the theory of colours appeared as complex and intricate before Sir *Isaac Newton's* time, as that of tastes does now; which is some encouragement to make an attempt.

P R O P. XXXIX.

To examine how far the several Sensations, which affect the Stomach and Bowels, may be explained agreeably to the Doctrine of Vibrations.

It will easily be conceived, that if tastes, properly so called (of which under the last proposition), flavour, or suit with, the doctrine of vibrations, the sensations of the stomach and bowels may likewise. But a particular examination of these sensations, and comparison of them with tastes, will make this more evident.

First, then, we may observe, that the stomach is less sensible than the tongue, the bowels in general than the stomach, and the inferior bowels than the superior. Thus opium, and bitters, and sometimes spirituous liquors are disagreeable to the tongue, but fall within the limits of pleasure in the stomach. Thus bile is extremely nauseous in the mouth, and offends even the stomach; but it cannot be disagreeable to the *duodenum*, which it first enters, or the bowels,

bowels, through which it passes. Thus also the *feces* seem to be equally suited to the several bowels along which they descend, though they grow perpetually more putrid and acrimonious in their descent, *i. e.* there is an abatement of sensibility in the bowels, which corresponds to the increase of acrimony in *feces*.

If it be objected here, that honey, *mercurius dulcis*, &c. offend the stomach and bowels often, though pleasant or insipid in the mouth, I answer, that such bodies require time, heat, solution, &c. before the whole of their qualities can be exerted.

Secondly, The particular manner in which opiates, fermented liquors, grateful aliments, and narcotics, may act first upon the stomach and bowels, and afterwards upon the whole body, agreeably to the doctrine of vibrations, has been given above in treating of sleep.

Thirdly, The action of vomits, purges, and acrid poisons, such as corrosive sublimate, is very reconcilable to this doctrine, by only supposing, that they excite very vigorous vibrations, and that these are communicated to the muscular coats of the stomach and bowels, to the muscles of the *abdomen*, and, in violent cases, to the whole muscular and nervous system. I shall consider the automatic motions, which arise from these causes, below, under a particular proposition. It may serve to shew the analogy of the sensations, and the general nature of active medicines, to observe, that these will often operate in several ways, *viz.* as vomits, purges, diuretics, diaphoretics, sternutatories, vesicatories, and corrosives, by a change of application and circumstances.

Fourthly, Since the meats, to which particular persons have an antipathy, and from which they receive violent ill effects, are, in general, highly grateful to others, one may perhaps conjecture, that the vibrations

vibrations excited by these meats in the stomachs of those who have an antipathy to them, do but just pass the limits of pleasure; so as to diffuse themselves much farther, and more powerfully, than if the first impression was very painful.

Lastly, The connection between the sensations of the tongue and stomach, and consequently between the manners of explaining them, may be inferred from the office of the taste, as a guide and guard to the organs of digestion; which is very evident, in general, in all animals, notwithstanding a few exceptions, more especially in men.

P R O P. XL.

To examine how far the Phenomena of Hunger are agreeable to the Doctrine of Vibrations.

NATURAL hunger may be reckoned a pleasure in its first rise, and to pass into a pain only by increase and continuance. We may suppose therefore, that during hunger the nerves of the stomach are so irritable, as that the common motions of the muscular coat, and the impressions made by its contents, in consequence of these motions, excite such vigorous vibrations, as first lie within the limits of pleasure, and afterwards pass into the limits of pain. And when the sight of food, or any other associated circumstance, increases the sense of hunger instantaneously, it may be conjectured to do so, in great measure, by increasing the contractions of the muscular coat of the stomach.

But the sensibility and irritability of the nerves of the tongue are also increased by hunger; for common aliments yield a very different taste, according as the person is satiated or hungry. And it is probable farther, that the nerves of the upper part of the bowels sympathize with those of the stomach in hunger; and increase the uneasy sensation, in violent degrees of it.

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Let us now consider in what way food may be supposed to lessen this sensibility and irritability of the nerves of the tongue, stomach and bowels; and how abstinence, bitters, wines, &c. may increase them, upon the principles of these papers.

First, then, As the small absorbing vessels in the mouth, stomach, and bowels, must, after eating for some time, be saturated with alimentary particles, those that are now applied will scarce make any impression for want of a sufficient attraction.

Secondly, Such as are attracted cannot make any considerable difference of vibrations, because the vibrations which they are qualified to excite, do already take place. And these two remarks, put together, shew, that a person may relish a second kind of food after being satiated with a first.

Thirdly, The actions of mastication, deglutition, and digestion, exhaust the neighbouring glands and glandular receptacles of their liquids, and the neighbouring muscular fibres, of their ready power of contracting: these parts are therefore no longer susceptible of a pleasurable state, or only in a low degree.

Fourthly, Abstinence reverses all these steps; in which, however, the perpetual affusion, dilution, and ablution of the saliva has a considerable share. And thus after a proper interval the organs return to a state of great sensibility and irritability.

Fifthly, Bitters and acids exhibited in a moderate degree seem gently to increase the vibratory motions, and raise them before the due time to the degree that corresponds to hunger. A small quantity of food has the same effect, also agreeable emotions of mind, fresh air, exercise, and many other things. But if the bitters, acids, &c. be carried beyond a certain degree, they occasion pain or sickness, which is very agreeable to the doctrine of vibrations, as laid down in these papers.

Sixthly,

Sixthly, In fevers the mouth, *fauces*, *oesophagus*, and stomach, are hot, dry, inflamed, and incrusted. They are therefore preoccupied by vibrations of a kind quite different from those which attend hunger, and therefore exclude this state.

It may not be amiss to observe here, that the sensation of hunger is a guide and guard to the organs of digestion in a still more eminent degree, than the tastes of the several aliments.

P R O P. XLI.

To examine how far the Phenomena of Thirst are agreeable to the Doctrine of Vibrations.

THIRST is opposite to hunger, and is a general attendant upon fevers. It follows also, in an evident manner from all considerable degrees of heat in the *fauces*. The nerves therefore of the mouth, *fauces*, *oesophagus*, and stomach, are, during thirst, preoccupied by disagreeable vibrations, of the inflammatory kind, as above observed. And as the pleasures of taste may be said to resemble those of distillation, so thirst seems allied to itching.

It is agreeable to this account of thirst, that liquors actually cold afford immediate relief; also that warm diluents, which soften the parts, and wash off acrimonious particles, do it after some time. As the cause of thirst is of a permanent nature in fevers, it must return again and again, till the fever be removed. Gentle acids yield a pleasure in thirst, which seems to correspond to that which scratching excites in parts, that itch previously.

P R O P. XLII.

To examine how far the Changes generally made in the Taste, in passing from Infancy to old age, are agreeable to the Doctrines of Vibrations and Association.

SOME of these changes are,

That sweets generally grow less and less agreeable, and sometimes even disagreeable, or nauseous at last.

That astringent, acid, and spirituous liquids, which displease at first, afterwards become highly grateful.

That even bitters and acrids first lose their offensive qualities, and after a sufficient repetition give a relish to our aliment.

And that many particular foods and medicines become either extremely pleasant or disgusting, from associations with passion, joy, hope of advantage, hunger, the pleasures of cheerful conversation, &c. or with sickness, vomitings, gripings, fear, sorrow, &c.

Now, in order to account for these changes, we may consider the following things.

First, That the organs become less and less sensible by age, from the growing callosity and rigidity of all the parts of animal bodies. The pleasant flavours may therefore be expected to become less pleasant, and the moderately disagreeable ones to fall down within the limits of pleasure, upon this account.

Secondly, The disposition to vibrations in the organ and corresponding part of the brain must also receive some alteration by the frequent repetition of impressions. For though this returns, at a proper distance from each meal, to its former state, within an indefinite distance, as one may say, yet some difference there probably is, upon the whole, which in a sufficient length of time amounts to a perceptible one.

one. However, we must also suppose on the other hand, that the make of the nervous system sets some bounds to this gradual alteration in the disposition to vibrate; else the taste would be much more variable than it is, and continue to change more after adult age, than it is found to do in fact. It may perhaps change faster in the use of a high diet than of a low one; which would be an evidence of the reality of the cause here assigned.

Thirdly, The pleasant and painful impressions which particular foods and medicines make upon the stomach, always either accompany the taste, or follow it in a short time; and by this means an association is formed, whereby the direct pleasantness or nauseousness of the taste is enhanced, if the impressions upon the tongue and stomach be of the same kind; or diminished, and perhaps overpowered, and even converted into its opposite, if they be of different kinds. For if the two impressions *A* and *B*, made upon the tongue and stomach respectively, be repeated together for a sufficient number of times, *b* will always attend *A* upon the first moment of its being made. If therefore *B* be of such a magnitude as to leave a trace *b* sufficiently great, the addition of this trace *b* to *A*, the impression made upon the tongue, may produce all the changes in it above-mentioned, according to their several natures and proportions. This follows from the doctrine of association, as it takes place in general; but here the free propagation of vibrations from the stomach to the mouth, along the surface of the membranes, adds a particular force. In like manner a disagreeable taste, by being often mixed with a pleasant one, may at last become pleasant alone, and *vice versa*: hunger and satiety may also, by being joined with particular tastes, contribute greatly to augment or abate their relish. And I believe it is by the methods of this third kind, that the chief and most usual changes in the taste are made.

Fourthly, the changes which are made by associations with mental pleasures and pains, or bodily ones not belonging to this organ, as with fine colours, music, &c. receive a like explication as the last-mentioned instances of associations. Here the pleasure excited in the eye or ear over-rules the taste at first: afterwards we may suppose the organ to be so altered by degrees, in respect of the disagreeable taste, from its frequent impression, or other cause, as to have the solution of continuity no longer occasioned by its action. It is probable also, that evanescent pleasures of sight and hearing, at least pleasant vibrations in the parts of the brain corresponding to these two organs, accompany these tastes ever afterwards.

It may be observed here, that the desire of particular foods and liquors is much more influenced by the associated circumstances, than their tastes, it being very common for these circumstances, particularly the sight or smell of the food or liquor, to prevail against men's better judgment, directing them to forbear, and warning them of the mischiefs likely to arise from self-indulgence.

P R O P. XLIII.

To examine how far the Longings of pregnant Women are agreeable to the Doctrines of Vibrations and Association.

HERE we must lay down previously, that the uterus is in a state of distention during pregnancy; and that it propagates sympathetic influences by means of nervous communications to the stomach, so as to put it into a state of great sensibility and irritability. All this will be easily acknowledged.

It follows therefore, since the limits of pleasure and pain are contiguous, that the stomach during pregnancy may at some times have an eager appetite

for food, as well as a nausea at others; that this appetite may be the more eager, because it borders upon a nausea; and that it will no more answer to the usual exigencies and circumstances of the body, than the nausea does. The same eager appetite will bring up the ideas of various aliments from prior associations; and if a new association of it, when particularly eager, happens to be made with this or that food or liquor, the sympathetic eager appetite will ever after bring in the idea of that food or liquor, and adhere inseparably to it. The same eager appetite may also be transferred upon something that is not properly a food, from its exorbitant nature, prior nauseas in respect of common food, and accidental joint appearance. And, upon the whole, the usual circumstances attending the longings of pregnant women are deducible from association, and are as agreeable to the doctrine of vibrations, as to any other yet proposed; or even more so.

It may illustrate this account to observe, that, in the usual cases of melancholy madness, an uneasy state seems to be introduced into the white medullary substance of the brain by the degeneration of the humours, or other such like mechanical cause, which carries the vibrations within the limits of pain, and raises an inflammation *sui generis* in the infinitesimal vessels of the medullary substance; that ideas of objects of fear, sorrow, &c. are raised, in consequence of this, by means of prior associations; and that, after some time, some one of these, by happening to be presented oftener than the rest, by falling more in with the bodily indisposition, &c. overpowers all the rest, excites and is excited by the bodily state of fear, sorrow, &c. till at last the person becomes quite irrational in respect of this one idea, and its immediate and close associates, however rational he may be in other respects. And a like account may be given of the violent particular desire towards a person of a different

sex, where this desire rests chiefly in the sensual gratification, and the beauty of the person. And all these three instances seem to me to favour the doctrine of vibrations a little, as well as that of association very much.

P R O P. XLIV.

To explain in what Manner and to what Degree, pleasant and unpleasant Tastes contribute, according to the Doctrine of Association, to form our intellectual Pleasures and Pains.

THE pleasures of the Taste, considered as extending itself from the mouth through the whole alimentary duct, are very considerable, and frequently repeated; they must therefore be one chief means, by which pleasurable states are introduced into the brain, and nervous system. These pleasurable states must, after some time, leave miniatures of themselves, sufficiently strong to be called up upon slight occasions, viz. from a variety of associations with the common visible and audible objects, and to illuminate these, and their ideas. When groups of these miniatures have been long and closely connected with particular objects, they coalesce into one complex idea, appearing, however, to be a simple one; and so begin to be transferred upon other objects, and even upon tastes back again, and so on without limits. And from this way of reasoning it may now appear, that a great part of our intellectual pleasures are ultimately deducible from those of taste; and that one principal final cause of the greatness and constant recurrency of these pleasures, from our first infancy to the extremity of old age, is to introduce and keep up pleasurable states in the brain, and to connect them with foreign objects.

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The social pleasures seem, in a particular manner, to be derived from this source; since it has been customary in all ages and nations, and is, in a manner, necessary, that we should enjoy the pleasures of taste in conjunction with our relatives, friends, and neighbours.

In like manner, nauseous tastes, and painful impressions upon the alimentary duct, give rise and strength to mental pains. The most common of these painful impressions is that from excess, and the consequent indigestion. This excites and supports those uneasy states, which attend upon melancholy, fear, and sorrow.

It appears also to me, that these states are introduced, in a great degree, during sleep, during the frightful dreams, agitations, and oppressions, that excess in diet occasions in the night. These dreams and disorders are often forgotten; but the uneasy states of body, which then happen, leave vestiges of themselves, which increase in number and strength every day from the continuance of the cause, till at last they are ready to be called up in crowds upon slight occasions, and the unhappy person is unexpectedly, and at once, as it were, seized with a great degree of the hypochondriac distemper, the obvious cause appearing no ways proportionable to the effect. And thus it may appear, that there ought to be a great reciprocal influence between the mind and alimentary duct, agreeably to common observation; which is farther confirmed by the very large number of nerves distributed there.

P R O P. XLV.

To give an Account of the Ideas generated by the several Tastes.

As the pleasures of taste are in general greater than those of feeling, and the pains in general less, it

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follows

follows that the ideas which are affixed to the several words expressing the several pleasant and unpleasant tastes, will be of a middle nature in respect of the ideas generated by tangible impressions; and lie between the ideas of the pains of feeling, and those of its pleasures.

Agreeably to this, it seems very difficult, or even impossible, to excite a genuine vivid, miniature of an acid, sweet, salt, or bitter taste, by the mere force of imagination. However, the vibrations peculiar to each of these leave such vestiges of themselves, such an effect in the tongue, and corresponding parts of the brain, as, upon tasting the qualities themselves, at once to bring up the names whereby they are expressed, with many other associated circumstances, particularly the visible appearances of the bodies endowed with these qualities. And these vestiges may be called ideas. Analogy leads us also to conclude, as before observed under feeling, that some faint vestiges or ideas must be raised in the parts of the brain corresponding to the tongue, upon the mere passage, of each word, that expresses a remarkable taste, over the ear. And, when the imagination is assisted by the actual sight or smell of a highly grateful food, we seem able to raise an idea of a perceptible magnitude. This is confirmed by the manifest effect exerted upon the mouth, and its glands, in such cases.

The sight of what we eat or drink seems also, in several instances, to enable us to judge more accurately of the taste and flavour; which ought to be effected, according to this theory, by raising small ideas of the taste and flavour, and magnifying the real impressions in consequence thereof. For an actual impression must excite vibrations considerably different, according to the difference in the previous ones; and where the previous ones are of the same kind with those impressed, the last must be magnified.

P R O P.

P R O P. XLVI.

To explain the automatic Motions, which arise from the Impressions made on the Organ of Taste.

THE motions dependent on the sensations of the tongue, and alimentary duct, may be thus enumerated: suction, mastication, deglutition, the distortion of the mouth and face in consequence of nauseous tastes, the peristaltic motion of the stomach and bowels, vomiting *ruetus*, hiccough, spasms, and violent motions in the bowels, the motions which empty the neighbouring glands, and the expulsion of the *feces*.

First, then, Suction in new-born children appears to depend chiefly on the sensations of the lips and tongue. I say *chiefly*, because some predisposition thereto may be generated *in utero*, or otherwise impressed, and the great aptness of new-born children in sucking seems to favour this. However, when we consider, that the impressions of the cold air upon the lips and mouth in its passage to the lungs, of the nipple upon the lips, and of the milk upon the tongue, ought to excite motions in the neighbouring muscles of the lips, and lower jaw; that the motions which concur to the action of suction, are such as might be expected from these causes; and even that the motions of the head and neck, by which the child indicates the want of a breast, may flow from the great sensibility and irritability of these parts, when the child is hungry; a presumption arises, that the whole action of suction, with all its circumstances, is excited by the impressions mechanically or automatically; and that by the running of vibrations from the sensory nerves into the neighbouring motory ones.

Secondly,

Secondly, The first rudiments of the action of mastication are derived from that of suction, *i. e.* from the alternate motion of the lower jaw necessary to squeeze out the milk. After this action has been excited for some time by the taste of the milk, it will return with sufficient facility from the impressions made by solid food; and the same impressions may excite other motions in the muscles of the tongue and cheeks, viz. those which concur to make the action of mastication in its imperfect and automatic state.

Thirdly, It may appear in like manner, that the pleasurable impressions of the milk upon the tongue, mouth, and *fauces*, of new-born children, may excite those motions of the muscles of the tongue, *as hyoides*, soft palate, and *fauces*, which make the action of deglutition; and consequently, that this is deducible from sensation automatically.

It confirms this position, that, according to the theory of these papers, the soft palate ought to be drawn down by the impressions made on the tongue and mouth, not drawn up; since this last would be to suppose the sensory vibrations to pass over muscles that are near, and run to those at a distance, which is absurd. For *Albinus* has proved, both from anatomy, and the observation of the fact, that the soft palate is drawn down in swallowing; not up, according to the opinion of *Boerhaave*.

It confirms it also, that nauseous liquids are immediately and mechanically rejected by young children; the impressions arising from them producing such a contraction as shuts the passage.

It confirms it still farther, that young children do not swallow their *saliva*. For this makes no impression sufficient to generate the action of deglutition in an automatic way.

We may conjecture here, that the common vibrations, excited in the membrane of the mouth and *fauces*,

fauces, grow particularly strong at the tip of the *uvula*; and that a greater power of contraction is transmitted to the neighbouring muscles upon this account.

Fourthly, It may be observed, that nauseous tastes distort the mouth and face automatically, not only in young children, but even in adults. And for the same reason, pleasant ones ought to have a less effect, of the same kind; as they seem to have. And I conjecture, that the distortions of the face, which attend grief, also the gentle, smiling motions, which attend joy, are, in part, deducible from this source.

I conjecture also, that the *risus sardonius*, and the tendency to laughter, which some persons observe in themselves in going to sleep, have a relation to the forementioned motions of the face. As the muscles here considered are, in great measure, cutaneous, they will on this account, be more subject to vibrations excited in the mouth, or which run up to it from the stomach.

Fifthly, It may easily be conceived, that the impressions, which the aliment and *feces* make upon the stomach and bowels, may excite the peristaltic motion in their muscular coats. It only remains to shew, why this should tend downwards. Now, for this, we may assign the following reasons. First, That the action of swallowing determines that of the stomach to move the same way with itself, *i. e.* downwards; and that this determination may, in common cases, carry its influence as far as the great guts. Secondly, That the contraction of the upper orifice of the stomach may stop the waves that sometimes come upwards in the stomach, and return them back, so as to force open the *pylorus* where that is less contracted; as on the other hand, where the *pylorus* is more contracted than the upper orifice, the motion of the stomach is inverted, and there arises a disposition

disposition to *ruetus* or vomiting. Thirdly, That, when waves ascend in the lower bowels, a gentle contraction in the *pylorus* may be sufficient to stop and return them. Fourthly, That one principal use of the *cæcum* and *appendicula vermiformis*, which last is an extreme and pointed part, seems to be, to return the waves, which the constriction of the *anus* may send upwards. And the effects of glysters and suppositories in procuring stools, *i. e.* in putting the whole *colon* into motion, agree well with this use of the *cæcum*, and *appendicula vermiformis*. It agrees also with all the reasoning of this paragraph, that when a stoppage is made any where in the bowels by an inflammation, spasm, strangulation from a rupture, &c. the peristaltic motion is inverted.

I have been informed, that in a person who had some inches of the *ilium* hanging out of his body, so that the peristaltic motion might be viewed, the least touch of a foreign body would stop this motion at once. It agrees with this, that when rabbits are opened alive, the peristaltic motion does not take place till after some time, *viz.* because the handling of the bowels has checked it. May we not hence suspect, that the fibres of the muscular coat of the bowels are contracted by an electrical virtue, which passes off, and disappears for a time, upon the touch of non-electrics? Or may we suppose, that such touches stop subtle vibrations in the small parts of the fibres?

Sixthly, Since vomiting is excited by disagreeable and painful impressions in the stomach, and requires the contraction of the diaphragm, and abdominal muscles, it agrees well with the notion, that sensory vibrations run into the neighbouring muscles for contracting them. I suppose also, that both orifices of the stomach are strongly contracted, previously to vomiting; and that the upper orifice, being most sensible, is contracted most strongly. Hence its

power

power of contraction may be soon exhausted, and consequently it may open of itself in the action of vomiting. However, it may, in some cases, require to be forced open by the superior action of the diaphragm, and abdominal muscles. Almost all great pains and disorders in the lower belly occasion vomiting; which is very agreeable to the foregoing notion.

The nose itches, the mouth flows with water, the lower lip trembles, both are pale, and the person yawns, previously to vomiting, in many cases; all which things favour the notion of vibrations running freely along the surfaces of membranes.

Ructus, or the expulsion of wind from the stomach, is nearly related to vomiting, differing rather in degree than kind. Its suitableness therefore to the theory of these papers must be judged of from what has been advanced concerning vomiting.

The hiccough is also related to vomiting. It is supposed to proceed from an irritation at the upper orifice of the stomach, causing a sudden contraction of the diaphragm, so as to pull down the *pharynx* and *larynx* after it. May it not rather be a sudden contraction of the inferior or small muscle of the diaphragm only? This is particularly near the supposed seat of irritation; and upon this supposition, sneezing, surprize, and all other methods of making the whole diaphragm act together strongly, would remove it, as is observed in fact.

Seventhly, Permanent spasms, and violent motions, in the bowels, arise in consequence of uneasy and painful impressions there from indigested aliment, acrid *feces*, irritating purges, poisons, &c. They are generally attended with the fermentation of the contents of the bowels, and the consequent generation of air; which, when confined by a spasm on each hand, distends the intermediate part of the bowel often to an excessive degree, causing a proportional degree of painful

painful vibrations. If we suppose these vibrations to check themselves all at once, by occasioning a sudden contraction in the affected membrane, they may be propagated over the whole nervous system instantaneously, and give rise to the convulsion fits, which happen to young children from gripes, and distention of the stomach and bowels, and to adults, from poisons, &c. This is upon supposition, that neither spasm gives way; for, if either does, the pain goes off, for a time at least, without farther ill symptoms. Such pains in the bowels resemble those in the bladder, when the *detrusor* and *sphincter* are both contracted violently at the same time, by the irritation of a stone. The stomach, the gall-bladder, and *rectum*, all seem capable of like contractions in muscular fibres, that have opposite actions. The causes of all these spasms and motions are evidently the impressions in the neighbourhood, and their circumstances are, at first sight, agreeable to the theory of these papers.

Eighthly, The glands belonging to the mouth, and alimentary duct, appear to me to be emptied, not only by the compression, which the neighbouring muscles and muscular fibres make upon them, but also by the sensory vibrations which run up their excretory ducts, into the *folliculi*, and receptacles where there are such, and even into the secretory ducts; by which the peristaltic motion of all these is increased, so as both to receive more freely from the blood during their state of relaxation, and to squeeze more strongly through the excretory ducts during their state of contraction. Thus tobacco, *pyrethrum*, and other acrids, solicit a profuse discharge from the salival glands, by being barely kept in the mouth, *i. e.* though the neighbouring muscles do not squeeze the glands by the action of mastication. Thus likewise vomits and purges increase both the secretions of all the glands of the intestines, and those of the

liver

liver and *pancreas*. It may be also, that the vibrations which run up the gall-duct are sometimes so strong as to occasion a spasm there; in which case, if the patient vomits at the same time, a symptomatic and temporary jaundice may follow.

Ninthly, The expulsion of the *feces* in new-born children is perfectly automatic, and seems to follow even from very gentle compressions of the abdominal muscles, when the *rectum* is full, inasmuch as the *sphincter ani* has in *them* scarce any force. The same may be said of the expulsion of the urine, the *sphincter vesicæ* being also very weak in new-born children. To which we may add, that the least irritation from fulness or acrimony in the *rectum* or bladder throws the abdominal muscles into contraction in young children, both on account of the extreme sensibility and irritability of their whole nervous systems, and because they have, as yet, no associated influences over the muscles of the *abdomen*, whereby to restrain their contractions.

As the sphincters of the *rectum* and bladder gain strength, more force is required to expel the *feces* and urine. However, it appears, that these muscles usually exhaust themselves, previously to the instant of expulsion, thus giving free scope to their antagonists. For, according to theory, they ought to be contracted sooner and stronger than their antagonists, as being nearer to the seat of irritation.

The actions of vomiting, and expulsion of the *feces*, are very nearly related to one another in their automatic state. However, it seems to me, that an irritation in the stomach produces only a gentle contraction in the *sphincter ani*, viz. such a one as does not exhaust its power, and which therefore tends to confine the *feces*. In like manner, an irritation in the *rectum* may gently contract the upper orifice of the stomach. It deserves notice here, that the *sphincter ani* lies out of the *peritonæum*; and consequently,

quently, that vibrations cannot run from it to the orifice of the stomach along the *peritonæum*, nor *vice versa*. The same observation holds in respect of the *sphincter* of the bladder.

The circumstances attending the exclusion of the *fœtus*, which continues automatic perfectly or nearly, may be much illustrated by what is here delivered concerning the expulsion of the *fæces*.

P R O P. XLVII.

To explain the Manner and Degree in which the automatic Actions, mentioned under the last Proposition, are influenced by voluntary and semivoluntary Powers.

WHEN young children continue to suck, or masticate a tasteless body put between their lips, or into their mouths, we may conceive, that the actions of suction and mastication begin to pass from their automatic towards their voluntary state. Drinking out of a vessel, so as to draw up the liquid, is learnt, in part, from sucking the breast, in most cases; but it may be learnt without, as is evident in those children that are dry-nursed. Mastication, when it approaches to a perfect state in children, is chiefly voluntary, the first rudiments receiving perpetual changes, so as to fall in more and more with pleasure and convenience. See *Prop. 22. Cor. 1.* In adults, both suction and mastication follow the command of the will with entire readiness and facility. The manner in which this is effected has been already explained in treating of the voluntary power of grasping.

Deglutition of insipid liquors becomes voluntary early. But it is difficult, even for some adults, to swallow pills and boluses, though tasteless; and very nauseous liquids are sometimes rejected by them automatically, as well as by young children. The action

action of deglutition affords manifest evidences of the gradual transition of automatic motions into voluntary ones, as well as of voluntary ones into such as are secondarily automatic. For, in common cases, we swallow without the least express intention.

When the face of a child or adult is distorted upon the sight of a nauseous medicine, which has before produced distortions automatically, *i. e.* from the impressions made on the mouth and *fauces*, we see an evident instance of the power of associated circumstances; and may have the conception of voluntary powers, derived from a succession of such associations, made easy to the imagination.

The peristaltic motion of the stomach and bowels remains automatic to the last, depending partly on the vibrations descending from the brain, partly on the impressions made on the villous coat. It cannot depend on associated circumstances in its common state, because, being perpetual, it is equally associated with every thing, *i. e.* particularly so with nothing. However, as grateful aliments increase it, the sight of them may do the same by association. Could we see our stomachs and bowels, it is probable, that we should get some degree of voluntary power over them.

Vomiting is sometimes, and a nausea often, excited by associated circumstances; and there have been instances of persons who could vomit at pleasure, by first introducing some of these. But, I suppose, this action never follows the mere command of the will, without the intervention of some strong associated circumstance. We have, in like manner, a semi-voluntary power of restraining vomiting, for a time at least, by means of ideas of decency, shame, fear, &c.

Some persons have a power of expelling flatulencies from the stomach in a manner which is almost voluntary; and many imitate an automatic hiccough

very exactly. It facilitates these powers, that both the motions here considered are very frequent, especially during childhood. Those who can hic-cough voluntarily, attain to it by repeated trials, as in other cases of voluntary actions.

The spasms, and violent motions of the bowels, cannot be expected to become voluntary. They do, however, seem to return, in many cases, from less and less bodily causes perpetually, on account of associated circumstances, as has been already remarked.

In like manner, the vibrations which run up the excretory ducts of the glands, must be supposed to remain totally under the influence of their original causes; unless we except the contraction of the gall-duct, which happens sometimes in violent fits of anger. This may perhaps arise from vibrations excited by associated circumstances.

Both the power of expelling the *feces* and urine, and that of checking this expulsion, are under the influence of many associated circumstances, and voluntary to a considerable degree. And it will easily appear, from the principles of this theory, that they ought to be so. The filling the chest with air by the contraction of the muscles of inspiration, is a circumstance which never attends these actions in their purely automatic state. Young children learn it by the same steps as they do other methods of exerting the greatest force, and to the greatest advantage. See *Prop. 22. Cor. 1.*

It deserves notice here, that the action of the muscular coat of the stomach and intestines is far less subject to the power of the will, than that of the great fleshy muscles of the trunk and limbs. The efficient cause of this is the great and immediate dependence which the action of the muscular coat has upon the sensations of the villous, on account of the exquisiteness of these sensations, their constant recurrency, and the contiguity of the coats. And there is a perfect agreement

agreement of the final cause with the efficient here, as in other cases. For any great degree of voluntary power over the muscular coat of the bowels would much disturb the digestion of the aliment as those nervous persons experience, who are so unhappy as to be exceptions to the general rule, through the influence of associated circumstances.

S E C T. III

OF THE SENSE OF SMELL.

P R O P. XLVIII.

To assign the Extent of the Organ of Smell, and to explain in general the different Powers of which it is possessed.

SMELL may be distinguished into two sorts: first, that exquisite sensation, which odoriferous bodies impress upon the nose by means of alternate inspiration. This is smell, in the peculiar and most proper sense of the word; and it resides chiefly, or perhaps entirely, in that part of the pituitary membrane, which invests the cells of the *ossa spongiosa*. Secondly, That sensation or flavour, which most kinds of aliment and medicines impress upon the whole pituitary membrane during mastication, and just after deglutition. And this last makes a principal part of the pleasures and pains which are usually referred to the taste. For when a person has a cold, *i. e.* when the pituitary membrane is obstructed and loaded with *mucus*, meats lose their agreeable flavours; and the same thing happens in a *polypus narium*.

Besides this, it is to be observed, that the pituitary membrane has an exquisite sensibility, which may be referred to the head of feeling. For active powders, *i. e.* sternutatories, seem to irritate the membrane of the nose in the same way, as they do a part of the skin deprived of the cuticle, only in a greater degree, and more immediately. And thus smells themselves may be referred to the head of feeling; since strong smells are often observed to occasion sneezing.

It may also be remarked, that as the organ of feeling passes insensibly into that of taste, so the organ

of taste does into that of smell. And these three senses have a much greater resemblance to one another, than any of them has to the sight, or to the hearing; or than the sight and hearing have to each other. However, the organ of feeling is distinguished from that of taste by its being covered with the hard cuticle, and the organ of taste from that of smell by the last's being extended upon bones; so as to be much more sensible and irritable upon that account. To which we may add, that as a watery fluid is the proper *menstruum* for the dissolution of sapid particles, and conveyance of their tastes, so smells seem to make their impressions by means of air-particles.

P R O P. XLIX.

To examine how far the general Phænomena of Smell are agreeable to the Doctrine of Vibrations.

HERE we may observe, first, that, since the smells of bodies diffuse themselves in general to great distances, and in some cases to immense ones, the odoriferous particles must repel each other; and consequently be easily susceptible of vibratory motions, for the same reasons as the particles of common air, or those of the æther. We may even suppose, that odoriferous particles are thrown off by vibratory motions in the body that emits them.

May not, however, the odoriferous particles be attracted by the body which emits them, after they have receded from it to a certain distance, and so follow it, in some measure, like an atmosphere? It is hard to account for the small or no diminution of weight in odoriferous bodies, after they have continued to emit smells for a long time, but upon some such supposition.

Secondly, Heat, friction, and effervescence, are all very apt to excite and increase smells; and have all a connection with vibratory motions in the judgment of most philosophers.

Thirdly, Since heat and friction excite and increase smells, these may have some connection with electricity; which is supposed by many philosophers to depend upon vibratory motions. And as air-particles are *electrics per se*, they may have, on this account, a peculiar fitness for conveying and impressing smells. May not air-particles, and odoriferous ones, repel each other?

Fourthly, It is usual, when we desire to receive a smell in full strength and perfection, to make quick, short, alternate inspirations and expirations. This corresponds to the rubbing the ends of the fingers upon the body to be examined by feeling, and the tongue against the palate in tasting. And all these three actions appear to be some presumption in favour of the doctrine of vibrations.

Fifthly, The greatness and quickness of the effect of odours upon the whole nervous system seem very suitable to the doctrine of vibrations. For this must be owing to the mere impression of some motion, there not being time for the absorption of particles sufficient for the effect produced. When sweet smells cause a sudden faintness, and *deliquium animi*, they may perhaps agitate the whole system of small medullary particles so much, as to make them attract each other with sufficient force to stop all vibratory motions; just as has been observed of the particles of muscular and membranous fibres. And the smells to which a person has an antipathy, may have been originally sweet, or lie so near the confines of pleasure, as to propagate their vibrations much farther than original fetids can. For these seem to revive from fainting by making a vigorous impression on the nose, which yet is not propagated freely over the whole system;

system; or, if it be, will occasion immediate sickness and fainting. Fetids in this resemble other pains, which, if moderate, excite; if very violent, overpower.

If it be objected to this, that such fragrant smells, as a person has an antipathy to, are disagreeable to him in the highest degree, and that upon the first perception; also that the smell of those fetids, which revive, as of *asa fætida*, spirit of hartshorn, &c. is agreeable to many; I answer, that these two opposite changes seem to arise merely from association. The faintness and revival, attending these smells respectively, must, by association, transfer the vestiges and miniatures of themselves upon the first perception of the smells, whose associates they are.

Sixthly, It is agreeable to the notion of vibrations, that spirituous liquors, and opium, should produce their appropriated effects by smell, as well as by being taken into the stomach, as they are found to do in fact. For, if these effects arise from specific vibrations, the mere impression of small active particles may be sufficient for the purpose of producing them. We must, however, suppose that the exhalations of odoriferous bodies are imbibed in some small degree by the absorbing vessels of the *membrana schneideriana*. We might shew by parity of reason, that the great subtlety of odoriferous *effluvia* favours the doctrine of vibrations.

Though odoriferous particles are more subtle than the sapid ones, yet they are perhaps grosser than the rays of light. For the smoke of a tallow candle ceases to smell, when it begins to shine, *i. e.* when it is more attenuated by heat. Since therefore the vibrations from heat are probably smaller than those from light, we may range the vibrations of the medullary substance in the following order, in respect of subtlety; heat, light, smell, taste, tangible impressions, and the vibrations of the air, from which sound arises. But it is to

be observed, that these last may excite much more frequent vibrations in the auditory nerve, than those of the sounding body, to which they correspond; just as the vibrations from friction are much more numerous, than the strokes of friction; and the tremors of the particles of an anvil much more numerous, than the strokes of the hammer.

P R O P. L.

To examine how far the specific Differences of Odours are agreeable to the Doctrine of Vibrations.

THIS proposition is analogous to the thirty-eighth, in which the agreement of the specific differences of tastes with the doctrine of vibrations is considered; and may be illustrated by it. One may say indeed, that taste and smell are so nearly allied to each other, that, if one be performed by vibrations, the other must also. I will repeat two principal observations.

First, If the varieties of kind in vibrations be combined with those of degree, we shall have a large fund for explaining the various fragrant and fetid smells, notwithstanding that the first always agree in falling short of the solution of continuity, the last in going beyond it.

Secondly, The differences of kind in smells are not so many as may appear at first sight, a difference in degree often putting on the appearance of one in kind. Thus an onion cut fresh, and held close to the nose, smells very like *asa fetida*; and *asa fetida*, in an evanescent degree, like onion or garlic. Thus a dunghil at a distance has smelt like musk, and a dead dog like elder-flowers. And fetids are said to enhance the flavour of fragrants. The three last instances shew, that pleasure and pain are very nearly allied to one another in this sense also.

P R O P.

P R O P. LI.

To explain in what Manner, and to what Degree, pleasant and unpleasant Odours contribute, in the Way of Association, to form our intellectual Pleasures and Pains.

IT will be evident, upon a moderate attention, that the grateful smells, with which natural productions abound, have a great share in enlivening many of our ideas, and in the generation of our intellectual pleasures; which holds particularly in respect of those that arise from the view of rural objects and scenes, and from the representations of them by poetry and painting. This source of these pleasures may not indeed be easy to be traced up in all the particular cases; but that it is a source, follows necessarily from the power of association.

In like manner, the mental uneasiness, which attends shame, ideas of indecency, &c. arises in a considerable degree, from the offensive smells of the excrementitious discharges of animal bodies. And it is remarkable in this view, that the *pudenda* are situated near the passages of the urine and *feces*, the two most offensive of our excrements.

We may suppose the intellectual pleasures and pains, which are deducible from the flavours, grateful and ungrateful, that ascend behind the *uvula* into the nose during mastication, and just after deglutition, to have been considered in the last section under the head of taste, since these flavours are always esteemed a part of the tastes of aliments and medicines. And indeed the olfactory nerves seem to have as great a share in conveying to us both the original and derivative pleasures, which are referred to the taste, as the nerves of the tongue; which may help us to account for the largeness of those nerves in men, to whom smell, properly

properly so called, is of far less consequence than any other of the senses, and taste of the greatest, while yet the nerves of taste are comparatively small.

We may add here, that the smell is a guide and guard placed before the taste, as that is before the stomach, in a great degree in men, but much more so in brutes, who have scarce any other means, than that of smell, whereby to distinguish what foods are proper for them. It is likewise probable, that the smell is a guard to the lungs; and that the grateful odours of flowers, fruits, and vegetable productions, in general, are an indication of the wholesomeness of country air; as the offensiveness of putrefaction, sulphureous fumes, &c. warn us beforehand of their mischievous effects upon the lungs. However, the rule is not universal in either case.

P R O P. LII.

To give an Account of the Ideas generated by the several Odours.

WHAT has been delivered concerning the ideas of feeling and taste, may be applied to the smell. We cannot, by the power of our will or fancy, raise up any miniatures or ideas of particular smells, so as to perceive them evidently. However, the associated circumstances seem to have some power of affecting the organ of smell, and the corresponding part of the brain, in a particular manner; whence we are prepared to receive and distinguish the several smells more readily, and more accurately, on account of the previous influence of these associated circumstances. And, conversely, the actual smells of natural bodies enable us to determine them, though we do not see them, always negatively, and often positively, *i. e.* by suggesting their names, and visible appearances. And, when we are at a loss in the last respect, the

name

name or visible appearance of the body will immediately revive the connection.

P R O P. LIII.

To explain the automatic Motions, which arise from the Impressions made on the Organ of Smell.

THESE automatic motions are of three kinds, viz. the inspiration, by which young brute animals, especially quadrupeds, impress and increase the odours of their respective foods; the contraction of the *fauces*, and upper part of the gullet, which arises from those agreeable flavours, which ascend behind the *uvula* into the nose; and the action of sneezing.

As to the first; it is peculiar to brutes, children not using any methods of improving odours, till they are arrived at two or three years of age. The reasons of this difference may be, that the smell in many brutes is the leading sense; that their noses are long and large, and the *ossa spongiosa* hollowed by innumerable cells; whereas in young children the nose is depressed; the pituitary membrane loaded with *mucus*; and, when they grow up, the acuteness of their smell is far inferior to that of quadrupeds.

If it be said, that this action is not automatic in brutes, but an instinct, which they bring into the world with them; I answer, that the nearness of the muscles affected, viz. those which dilate the nose, *larynx*, and lungs, to the seat of the impression, makes it probable, that the motion depends upon the sensation, as in other instances mentioned in these papers, some of which are allowed by all.

It may be, that something of the same kind takes place in young children, as soon as their smell begins to be sufficiently acute. But it is so mixed with, and modelled by, voluntary motions, as to be separately indiscernible.

The

The second motion, or the contraction of the *fauces*, and upper part of the *oesophagus*, from the grateful flavours which ascend up into the nostrils behind the *uvula*, is part of the action of deglutition; but it could not properly be mentioned in the last section, because it arises from a sensation referred to this.

Ungrateful flavours have often a contrary effect, and extend their influence so far as to preclude the passage through the gullet, and even throw back the ungrateful liquid or morsel with violence. And we may observe, that, in many other cases also, when the pleasure passes into pain, the automatic motion thereon depending passes into one of an opposite nature; just as in algebra, when an affirmative quantity in the *data* is changed into a negative one, a like change is to be made sometimes, and yet not always, in the conclusion.

It deserves notice here, that pinching the nose prevents the perception of these flavours, as it seems, by checking the vibrations, which would run along the pituitary membrane. When the flavours are very pungent, they fix in the tip of the nose; or, if this be hindered by pinching the nose, they fly to the *uvula*, which is the nearest extreme part to this.

In like manner, pinching the nose, or pressing the lacrymal bag, whose membrane is continuous to the pituitary one, checks the sensation that gives rise to sneezing. And when looking at a strong light excites this action, or acrid vapours make the eyes water, we may conjecture, that vibrations pass through the lacrymal duct from the eye to the nose in the first case, and from the nose to the eye in the last. The watering of the eyes from drinking hastily, especially pungent liquors, from plucking a hair out of the nostrils, and from sternutatories, admit of a like explication.

And these instances may help to explain the sensations in the *fauces*, *uvula*, and tip of the nose, also

the flowing of tears from the eyes, which attend grief. I conjecture that the stomach is particularly affected in grief; and that it sends up vibrations, along the common membrane, to the *fauces, uvula*, tip of the nose, and eyes. However, the disorder of the medullary substance is great and general in great mental uneasinesses.

As to sneezing; no one can doubt its being automatic. And it is reasonable to expect, that the muscles actually concerned in it, viz. those of inspiration, and the erectors of the head and neck, should be affected by vivid sensations in the pituitary membrane. It seems also to me, that the muscles which stop the passage through the nose, ought to be contracted first, *i. e.* during the inspiration, as being nearer to the seat of irritation; and afterwards relaxed during expiration, partly by their having exhausted their own power, partly by the contraction of their antagonists, which are irritated also. The contrary happens, but for the same general reasons, in the action of deglutition as has been already observed. And there is a remarkable coincidence of the efficient and final causes in both these instances.

In speaking of the sources of motory vibrations above, *Prop. 18.* I supposed, that, just before the motory vibrations excited by the irritation of membranes took place, the sensory ones in them were checked by the general contraction of their fibres, in all their directions. And I mentioned sneezing, as affording an instance of this. For the sensation, which causes it, disappears the instant before the inspiration; and, if this be not strong enough, *i. e.* the muscles do not receive the vibrations from the pituitary membrane with sufficient freedom, it returns again and again, being increased by this recitation, till at last it causes sneezing. It seems agreeable to this account, that the passage of air, should absolutely or relatively, through the nose, will often

often occasion sneezing; and through the mouth, yawning. For cold air must contract the membranes, along whose surfaces it passes.

When sneezing rouses from a stupor, it may be supposed to excite the usual degree and kind of vibrations in the medullary substance of the brain, by such a moderate concussion of it, as lies within the limits of nature and health.

P R O P. LIV.

To explain the Manner and Degree, in which the automatic Actions, mentioned in the last Proposition, are influenced by voluntary and semivoluntary Powers.

THE short, quick, alternate inspirations and expirations, by which we distinguish smells in perfection, are in men, totally or nearly, a voluntary action, derived partly from common respiration, partly from sneezing, the prospect of pleasure and convenience concurring to it, and modelling it, as in other cases. It seems also, that in brutes this action must pass from its pure automatic state to some degree of a voluntary one.

In what manner and degree deglutition is voluntary, has been considered already.

Sneezing is checked for a time by attention, surprise, and all strong mental emotions. It may also be performed voluntarily; but then the force is much inferior to that of automatic sneezing. The same may be observed of hiccough, coughing, yawning, stretching, &c. and is very agreeable to the derivative nature of these motions, when voluntary, i. e. when performed by motory vibrations. The action of sneezing is differently modelled by voluntary and semivoluntary powers in different persons.

S E C T. IV.

OF THE SENSE OF SIGHT.

P R O P. LV.

To determine the immediate Organ of Sight, and explain its Powers in general.

SINCE the *retina* is an expansion of the optic nerve, we may conclude, from the analogy of the other senses, that it is the immediate organ of sight. Nor is the want of sensibility in the button of the optic nerve, a sufficient objection to this; as the minute structure and disposition of the parts of this button are not known.

We may also reason thus to the same purpose. It may be expected, that the immediate organ of sight should be either black or white, that so it may bear a relation of indifference to all the colours. But if we admit the doctrine of vibrations, black, by absorbing all kinds of rays, would make a confusion of vibrations, whereas white, by reflecting all, might retain the impressed vibrations distinctly. The *retina* is therefore peculiarly fitted for the immediate organ of sight, and the *choroides* the contrary. We may add farther, that the *retina*, by reflecting rays copiously, prevents their arrival at the *choroides*.

For the accurate distinction of the several visible points of objects, it is necessary, that these be placed within the limits of distinct vision; and also, that the coats and humours of the eye be so circumstanced, as to bring the several pencils of rays, which proceed from each visible point, accurately or nearly, to a corresponding point upon the *retina*. This is distinct vision. But colours alone may be distinguished

distinguished from each other without any exact conformation of the eye. Thus vision may be reckoned of two kinds, as feeling, taste, and smell, have been.

P R O P. LVI.

To examine how far the Phenomena of Colours are agreeable to the Doctrine of Vibrations.

HERE I will make two suppositions.

First, That the extreme red rays at *F M*, *Optics*, book I. part II. fig. 4. excite vibrations in the *retina*, which are to those excited by the extreme violet rays at *A G*, as 1 to 2, in respect of frequency.

Secondly, That, in going from the extreme red to the extreme violet; the excess of vibrations excited by each colour, above those of the extreme red, will be proportional to its distance from the extreme red.

If we admit these two suppositions, then the vibrations excited by the extreme red, by the limit of red and orange, of orange and yellow, yellow and green, green and blue, blue and indigo, indigo and violet, and by the extreme violet, as these colours are fixed by Sir *Isaac Newton*, will be to one another in frequency, respectively, as the eight numbers 100, $112\frac{1}{2}$, 120, $133\frac{1}{3}$, 150, $166\frac{2}{3}$, $177\frac{7}{9}$, and 200; the distances of these several limits, and of the extreme violet, from the extreme red, being to one another respectively, as the seven numbers $12\frac{1}{3}$, 20, $33\frac{1}{3}$, 50, $66\frac{2}{3}$, $77\frac{7}{9}$, and 100.

Now the first supposition may be rendered probable thus. The intervals of the fits of easy reflection and transmission of the red and violet in the same medium, and same angle of refraction, are nearly as 5 to 3. See *Optics*, book II. obs. 14. and prop. 16. But the red is less refracted by the coats and humours of the eye than the violet

and consequently will not have its intervals so much diminished in proportion; whence they may be to those of the violet as 6 to 3, or 2 to 1, at their arrival on the *retina*. But it is probable, that the vibrations of the rays themselves, and consequently those which they excite in the *retina*, are reciprocally as the intervals of their fits. The frequency therefore of the vibrations excited by the extreme red may be to that of the vibrations excited by the extreme violet as 1 to 2, according to the first supposition.

The second supposition is an easy step after the first.

For it is natural to suppose, that in passing from *F* to *A*, in the figure above referred to, equal distances should produce an equal increase of vibrations, which is the second supposition.

Upon this foundation we may now reason in the following manner.

First, The seven primary colours, estimated both from their limits, and their middle points, excite vibrations, which are to each other in the simplest ratios that are consistent with each other, and all comprehended within the first and most simple of all ratios, viz. that expressed by the two first numbers 1 and 2.

Secondly, The same ratios are also those of the five tones, and two semitones, comprehended within the octave; as might well be expected. For music must take those which are most simple, and most consistent with each other.

Thirdly, Since the greens are respectively to the yellows, on one hand, as 9 to 8, and to the blues, on the other, as 9 to 10, *i. e.* in the proportion of a tone; also to the reds, on one hand, as 4 to 3, and to the violets, on the other, as 3 to 4, *i. e.* in the proportion of a fourth; since farther, the yellows are as 6 to 5, *i. e.* thirds minor, to the reds, as 4 to 3, *i. e.* thirds major, to the violets, as 5 to 4, *i. e.* thirds minor.

5, *i. e.* thirds major, to the blues, and as 2 to 3, *i. e.* fifths, to the violets; the blues as 5 to 6, *i. e.* thirds minor, to the violets, and as 3 to 2, *i. e.* fifths, to the reds; and the reds as 9 to 16, *i. e.* flat sevenths, to the violets; the difference of vibrations here exhibited may make the five foregoing colours appear distinct from each other to the mind, for the same reasons, whatever they be, as take place in sounds. For natural bodies reflect all these colours in great abundance, and in sufficient purity for this purpose. We may begin from green, as the most common of all. When this, as reflected by grass, suppose, has been sufficiently familiarized to the eye of a child, it is reasonable to think, that it may be distinguished from yellow and blue, and much more from red and violet, as reflected by flowers; also that these may be distinguished from each other. And it seems to me, that our fixed point ought to be placed in green, from the commonness and purity of the green of the third order, *i. e.* of grass and vegetables in general. For the same reasons one may expect, that the several shades of red, orange, green, blue, and violet, should be considered as several degrees of the same colour, viz. on account of the small difference of vibrations. At least this corresponds to the usual method of proceeding in other things. We distinguish great differences in our sensations by new names; but refer all such as are nearly related to the same. And thus the two foregoing suppositions furnish us with a natural reason for distinguishing the primary colours into five, viz. red, yellow, green, blue, and violet; which, agreeably to this, were all that Sir *Isaac Newton* himself distinguished the oblong solar image into for some time, as may appear by his *Optical Lectures*.

Fourthly, Since, if we proceed from the green to the yellow and red, on one hand, and to the blue and violet, on the other, the ratios are the same, only inverted;

verted; and since there is a larger interval or ratio between the yellow and red, also between the blue and violet, than between the green and yellow, or green and blue; we may expect to have two more distinct primary colours corresponding to each other, and to the two semitones in an octave. And thus it is. Orange, and indigo, are sufficiently distinct from their contiguous ones, viz. orange from red and yellow, and indigo from blue and violet; and yet approach to them. And these seven colours thus fixed, seem to be all that we can well call distinct colours amongst the primary ones, the intermediate degrees being referred to some of these seven, and called shades. Of compound colours, distinct from all the primary ones, I shall speak below.

Fifthly, It is remarkable here, that the order of the five tones and two semitones of an octave, which corresponds to the order of the seven primary colours, is the second in absolute perfection (which I have from a M S. paper of Sir *Isaac Newton's* on music, not yet published), and the first in relative, *i. e.* of those, in which the semitones are at equal distances from the middle or extremes; which circumstance is evidently necessary in the order of the colours. For distinct colours arise from ratios, and a half-note colour arise next after the red, if you begin at one end, a corresponding one ought to appear next after the violet, if you begin at the other. The sameness of the ratios, that must arise, makes this necessary, in supposition, that the distinction of colours is founded on ratios.

Sixthly, If the distinction of colours arise from the ratios of vibrations, the colours may be expected to be broader where the vibrations are more numerous, because a greater addition must be made to a greater number, in order to make an equal ratio. And there is a certain breadth for each of the colours respectively, which suits each set of ratios of vibrations

tions that they can be supposed to bear to one another, according to any supposed law of increase of the vibrations in passing from one end of the solar image to the other. Since therefore the breadth of the seven primary colours, as determined by Sir *Isaac Newton*, suits the simplest ratios possible, according to the simplest law of increase possible, as has been explained above, we seem to have from thence an argument both for the doctrine of vibrations in general, and for the particular ratios of vibrations here alleged. And there are two things in this matter which deserve particular notice. First, that Sir *Isaac Newton's spectrum* was about ten inches long; and consequently, the breadths of the seven primary colours, red, orange yellow, green, blue, indigo, violet, in inches, 1, 25; 0, 75; 1, 33; 1, 66; 1, 66; 1, 11; 2, 22; which magnitudes are so considerable, that a small error in fixing the limit of a colour does not much affect their mutual ratios. Secondly, that the limits of the colours were determined in a way, that had no dependence on any hypothesis, and the operation repeated several times. However, it may perhaps be worth the time and pains of some curious experimenter, to examine the breadths of the seven primary colours afresh, and compare them with the hypothesis here proposed.

Seventhly, When all the rays reflected from any natural body are near to each other, as in the yellows of the second order, and in the blues and greens of the third, we may suppose, that the slower vibrations are accelerated by the quicker, and the quicker retarded by the slower, so as to compose an intermediate colour, scarce differing from homogeneous light in appearance of purity; just as in a bell, the slower vibrations of the wider part, and the quicker of the narrower, over-rule each other mutually, so as to compose one tone. But when the vibrations of the

extreme

extreme rays are greatly different from each other, it seems that each ought to keep the power of exciting its proper vibrations, so as to make the colour of the middle rays; which may be considered as a kind of centre of gravity, a dilute one, verging to white. And white itself, when in perfection, arises from a due proportion of all the sorts of rays, each primary colour, perhaps, keeping its own peculiar vibrations, and the several shades of each primary colour vibrating in the same time as the middle point. When two colours considerably different, as red and blue, yellow and violet, red and violet, are compounded, they neither resemble the intermediate homogeneous one, nor make a white. Not the first, because they are at so great a distance, that each can keep its own vibrations, contrary to what happens in colours resembling homogeneous ones; not a white, because there is not a sufficient number of differing vibrations. By such compositions it is, that purples, and other colours, different from all the homogeneous ones, are formed; and whoever considers the several shades of each colour, with the mutual proportions which may be combined in any compound, may easily conceive how all the colours of natural bodies should arise from mere combinations of the primary colours, agreeably to the sixth and seventh Propositions of the second Part of the first Book of Sir *Isaac Newton's Optics*. What is here delivered may serve to suit the doctrine of vibrations to those propositions, and, perhaps, assist the reader to see the reasons of the sixth.

COR. If the differences of the primary colours arise from the specific differences of vibrations, it is easy to see, that the differences of tastes and smells may have a like origin; and *vice versa*.

P R O P. LVII.

To examine how far luminous Appearances, not occasioned by the Impression of the Rays of Light, with some other Phænomena of a related Kind, are agreeable to the Doctrine of Vibrations.

FLASHES of light, and other luminous appearances, are occasioned by strokes upon the eye, rubbing it, faintings, &c. Now it is very easy to conceive, that violent agitations in the small particles of the optic nerve should arise from these causes; and consequently that such deceptions of the sight, as one may call them, should be produced, if we admit the doctrine of vibrations. And I do not see how they follow from the common hypothesis concerning the manner of sensation.

The most remarkable of these luminous appearances is that which resembles the eye of a peacock's feather, and which offers itself upon shutting and rubbing the eye in a morning. There is a distinction in it between the central parts and the edges. The first seem to answer to that part of the *retina*, which is opposite to the pupil, and of about the same size with it, in its ordinary dimensions. The last, or the edges, may answer to those parts of the *retina*, which are only sometimes exposed to the action of light, viz. in dilatations of the pupil. It is observable, that the central parts are often dark, while the edges are luminous; and *vice versa*. It happens also frequently, that in the whole appearance a blue, a dilute yellow, and a red, succeed each other in the order of the colours. Perhaps, by farther observations, a person might be able, in some measure, to predict the variations of this phænomenon. It generally moves, which may be perhaps from the motion of the peculiar vibrations along the surface of the *retina*.

Upon

Upon shutting one's eyes after they have been fixed upon a luminous object, as a candle, a fire, a window, it is common to have a faint image of the object remain in the eye for a few moments. This follows from the gradual declension of the vibrations excited.

Sometimes, instead of a luminous image, a dark one, corresponding in shape and size to the luminous object, presents itself. In this case we must suppose, that the vivid vibrations excited by the luminous object pass immediately into very feeble ones, absolutely or relatively, upon the cessation of the impression.

Boerhaave says, that he had a luminous circle in his eye for along time after having viewed too intensely the moon's light collected to a *focus*. And looking at the sun makes other objects appear red and luminous. It does also occasion dark spots to appear upon common objects afterwards. This last effect may perhaps succeed the first. While extraordinary vibrations, or a disposition to them, continue in the *retina*, and optic nerve (which may be for a long time, if a slight inflammation, with the consequent irritability, be produced in the small vessels of the nervous capillaments), the common objects may appear luminous. When these go off, a contrary state may take place, and cause the dark spots to appear. Dark spots of continuance argue, that an injury is done to the *retina*, and optic nerve. The permanent dark spots, which are sometimes previous to a *gutta serena*, seem to be of this kind.

It is agreeable to some of the foregoing instances, that being kept much in the dark should enable the persons to see with a very obscure light. In some other cases of a *nyctalopia* there may perhaps be the first and lowest degree of inflammation in the infinitesimal vessels of the *retina*, so as to increase the sensibility of the organ without making the exercise of its functions painful.

Giddiness, or an apparent irregular motion in the objects of sight, almost always goes before any general confusion and privation of sense and motion; which is very agreeable to the doctrine of vibrations. For the general disorder in the vibrations in the medullary substance may be expected to be perceived in the optic nerve, and corresponding part of the brain, first and chiefly, on account of the acuteness and precision of the sense of sight. Upon the same principles it is easy to see, how great and unusual agitations of the body, impressions on the stomach, on the olfactory nerves, on the eye, by the quick transition of objects, on the eye and fancy together, by looking down a precipice, &c. should occasion a temporary giddiness.

P R O P. LVIII.

To examine how far the Judgments which we make by Sight concerning Magnitude, Distance, Motion, Figure, and Position, are agreeable to the Doctrine of Association.

I HAVE already observed, *Prop. 30.* that these judgments are to be esteemed true or false, according as they agree or disagree with those made by touch.

Now the associates of greater tangible magnitude are a larger picture on the *retina*, the distance being the same; and a larger distance, the picture being the same. The associates of a less tangible magnitude are the opposites to these. And the associates of the sameness of tangible magnitude are the increase or diminution of the picture on the *retina*, while the distance is diminished or increased suitably thereto. All this appears from optical considerations. Hence it follows, that where the picture on the *retina* is of a just size, and also the previous judgment concerning the distance just, our estimate of tangible magnitude by sight will be just likewise. But if the picture on
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the *retina* be magnified or diminished by glasses, or our previous judgment concerning the distance be erroneous, our estimate of tangible magnitude will be erroneous in like manner. And, whether it be just or erroneous, it is entirely founded on association.

The following instances, among many others, confirm these positions. Young children judge rightly of magnitude only in familiar places, or at small distances. At great distances they always judge the objects to be less than the truth, not having learnt to judge rightly of these distances, and make allowance for them. The generality of adults judge far better of magnitude at great distances on level ground, than from above, or from below, on account of their greater experience in the former case. The horizontal moon appears larger than the meridional, because the picture on the *retina* is of nearly the same size, and the distance esteemed to be greater. And yet the horizontal moon appears far less than the truth, because we can form no conception of its vast distance. A tree referred to the horizon in the dusk of the evening, or a fly to the ground at a distance, through the indistinctness of vision, appears much bigger than the truth. In looking through glasses, which magnify or diminish the picture on the *retina*, the objects themselves seem to be magnified or diminished, because our judgment concerning the distance is not altered proportionally; &c. &c.

There are, besides these, some other associated circumstances, which occasionally impose upon us in estimating magnitudes. Thus a person of an ordinary height standing near a very tall one, or coming in at a very high door, appears shorter than the truth; lean persons seem tall, fat persons short, &c.

The principal criterion of distance is the magnitude of the picture, which some known object makes on the *retina*. But the five following associated circumstances seem to have also some influence on our judgments

ments concerning distance, in certain cases, and under certain limitations: the number of objects which intervene, the degree of distinctness in which the minute parts are seen, the degree of brightness, the inclination of the optic axes, and the conformation of the eye. It will appear from the sixty-second and sixty-third propositions that the two last are associates to each other in their proper degrees, since each depends on the distance of the object. The influence of the three first, as well as that of the magnitude of the picture on the *retina*, is evident from the methods of expressing distance in pictures.

From the principles laid down in the last paragraph, we may explain the following fallacies in vision. An object viewed through a perspective appears to be nearer than it is, because the picture on the *retina* is thereby rendered both larger, and more distinct; but if we invert the perspective, and so diminish the picture, the object will appear farther off. At sea, and on plains, where few or no objects intervene, we judge the distances to be less than the truth; and the contrary happens in scenes diversified with a proper variety of objects. A large object, when apprehended to be one of a common size, appears nearer than the truth; and the same happens, when we view objects in rural scenes, such as houses, towns, hills, &c. in a bright light, or through a very clear atmosphere. In trying to judge of small distances by one eye, it is usual to be mistaken for want of the criterion from the inclination of the optic axes.

Since our judgment concerning the magnitude of an unknown object depends upon the distance, and our judgment concerning the distance of every object chiefly upon that concerning its magnitude, the conjectures of different persons, concerning the magnitudes and distances of unknown remote objects, both as seen through telescopes, and with the naked eye, may vary considerably from each other according to their

their respective associated prejudices. If the distance be fixed previously by a known object, we may afterwards judge of the magnitude of an unknown object thereby. The number of intervening objects, and the inclination of the optic axes, seem to afford considerable assistance in determining distances, where known objects are wanting; the first in large distances, the last in small ones: but the other three inferior criterions above-mentioned, viz. the degree of distinctness, the degree of brightness, and the conformation of the eye, when singly taken, are of small signification.

We judge of motion by the motion of the pictures on the *retina*, or of our eyes in following the objects. After some time, we learn to make allowance for the line of direction, our own motions, &c. If we fail to make the due allowance through associated circumstances of any kind, we must, in consequence of this, make a disproportionate estimate of motion, or place it in an undue object.

We judge of the figure or shape of bodies, chiefly by the variations of light and shade; and our associations taken thence are so strong, as that we are easily imposed upon by a just imitation of the light and shades belonging to each shape and figure, in their several situations with respect to the quarter from which the illumination proceeds.

It is from the associations, considered under this proposition, and particularly in the last paragraph, that painting conveys such exact ideas of shapes, figures, magnitudes, and distances, and the *camera obscura* of motions also, by means of impressions that proceed from a plane surface.

The position of objects is judged of entirely by the part of the *retina* on which the rays fall, if we be in an erect posture ourselves. If we be not, we allow for our deviation from it, or make a reference to something judged to be in an erect posture. If we fail

fail in these, errors concerning the position of visible objects must happen. Our calling bodies *erect*, when the rays proceeding from their tops fall upon the lower parts of the *retina*, and *vice versa*, is merely from an association of the same kind with those by which the senses of other words are determined.

Those who are disposed to examine the subjects of this and the following proposition with accuracy, may see a large variety of proper instances well explained by Dr. *Smith*, and Dr. *Jurin*, in Dr. *Smith's* Optics. These gentlemen insist chiefly on optical considerations; but they every where admit the prevalence of association, though it is not always to their purpose to take express notice of it.

I will just remind the reader, that in all the cases of magnitude, distance, motion, figure, and position, the visible idea is so much more vivid and ready than the tangible one, as to prevail over it, notwithstanding that our information from feeling is more precise than that from sight, and the test of its truth. However, if we could suppose a person to be endued with the senses of seeing and hearing, and yet to be destitute of that of feeling, and of the power of moving himself, he might have all the words expressing distances, magnitudes, &c. so much, and so properly, associated with the visible appearances of these, as that, by passing over his ear, they would raise up all the same trains of visible ideas, as in us.

P R O P. LIX.

To examine how far the Circumstances of single and double Vision are agreeable to the Doctrine of Association.

WHEN we have attained a voluntary power over the external motions of our eyes, so as to direct them to objects at pleasure, we always do it in such a manner, as that the same points of objects fall upon
correspondent

correspondent points of the two *retinas*. And this correspondence between the respective points of the *retinas* is permanent and invariable. Thus the central points, or those where the optic axes terminate, always correspond; a certain point on the right side of the right *retina* always corresponds (whatever object we view) to another certain point on the right side of the left *retina*, equally distant from the centre with it, &c. Hence, if the optic axes be directed to the object *A*, the picture made by it on the right *retina* corresponds to that made on the left; whereas the impressions made by two similar objects, *A* and *B*, upon the two *retinas*, do not correspond. The impressions therefore, that are made upon portions of the *retinas*, which do or do not correspond, are the associated criterions of single and double vision. For I here suppose, that the common appearances of a single object, and two similar ones, are respectively called single and double vision.

Let us now inquire into the fallacies which these associated criterions may occasion.

First, then, When a person directs his eyes by a voluntary power to a point nearer or farther off than the object which he views, so as to make the pictures of the object fall upon the points of the two *retinas*, that do not correspond, this object will appear double. The same thing happens when one eye is distorted by a spasm, when persons lose the voluntary power of directing their optic axes to objects, and in general whenever the pictures, which the object imprints on the two *retinas*, fall upon points that do not correspond.

It resembles this, and illustrates it, that if we cross the fingers, and roll a pea between two sides, which are not contiguous naturally, it feels like two peas.

Secondly, After a person, whose eye is distorted by a spasm, has seen double for a certain time, this
ceases,

ceases, and he gains the power of seeing single again, provided the distortion remains fixed to a certain degree. For the association between the points of the two *retinas*, which corresponded formerly, grows weaker by degrees; a new one also between points, that now correspond, takes place, and grows stronger perpetually.

Thirdly, If two lighted candles, of equal height, be viewed at the distance of two or three feet from the eyes, so that the picture of the right-hand candle on the left *retina* shall correspond to that of the left-hand candle on the right *retina*, only one image will be produced by these two corresponding pictures. But the two pictures which do not correspond, viz. that of the right-hand candle on the right *retina*, and that of the left-hand candle on the left *retina*, will each produce its proper image. See *Smith's Optics*, Rem. 526.

But here two questions may be asked: First, Why single objects appear the same to one as to both eyes, allowing for the diminution of brightness, since, in the first case, there is one picture only, in the last two. Ought not every single object to appear single to one eye, and double to both?

Secondly, How can one object appear like two to both eyes, since, however the eyes be directed or distorted, it can make but two pictures, whereas two objects make four, viz. two in each eye?

It is evident, that the difficulty is the same in both these questions. And it seems to be a sufficient answer to allege, that impressions so much alike, and which are so constantly made together, as those upon the corresponding portions of the two *retinas*, must unite into one entirely in the brain, and produce the same effect in kind, though somewhat different in degree, as one alone. And thus, whether we see with one eye or both, hear with one ear or both, the impression on the common sensory in the brain is the same

same in kind; and therefore, if the first be called single, the other must also.

But it deserves particular attention here, that the optic nerves of men, and such other animals as look the same way with both eyes, unite in the *bellula turcica*, in a *ganglion*, or little brain, as one may call it, peculiar to themselves; and that the associations between synchronous impressions on the two *retinas* must be made sooner, and cemented stronger, on this account; also, that they ought to have a much greater power over one another's images, than in any other part of the body. And thus an impression made on the right eye alone by a single object, may propagate itself into the left, and there raise up an image almost equal in vividness to itself: and consequently, when we see with one eye only, we may, however, have pictures in both eyes; and when we see a single object, with our eyes directed to one at a different distance, we may have four pictures, viz. two from direct impression in parts that do not correspond, and two others from association in parts that do. And thus both the foregoing questions may be answered, in a manner that leaves no doubt or hesitation.

P R O P. LX.

To explain in what Manner, and to what Degree, agreeable and disagreeable Impressions on the Eye contribute, in the Way of Association, to form our intellectual Pleasures and Pains.

It is evident, that gay colours, of all kinds, are principal source of pleasure to young children; and they seem to strike them more particularly, when mixed together in various ways. Whether there be any thing in colours, which corresponds to the harmony between sounds, may be doubted. If there be,
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it must, however, admit of much greater latitude than the harmony between sounds, since all mixtures and degrees of colours, unless where the quantity of light overpowers the eye, are pleasant; however, one colour may be more so originally than another. Black appears to be originally disagreeable to the eyes of children; it becomes disagreeable also very early from associated influences. In adults, the pleasures of mere colours are very languid in comparison of their present aggregates of pleasure, formed by association. And thus the eye approaches more and more, as we advance in spirituality and perfection, to an inlet for mental pleasure, and an organ suited to the exigencies of a being, whose happiness consists in the improvement of his understanding and affections. However, the original pleasures of mere colours remain, in a small degree, to the last, and those transferred upon them by association with other pleasures (for the influence is in these things reciprocal, without limits) in a considerable one. So that our intellectual pleasures are not only at first generated, but afterwards supported and recruited, in part from the pleasures affecting the eye; which holds particularly in respect of the pleasures afforded by the beauties of nature, and by the imitations of them, which the arts of poetry and painting furnish us with. And for the same reasons the disagreeable impressions on the eye, have some small share in generating and feeding intellectual pains.

It deserves notice here, that green, which is the colour that abounds far more than any other, is the middle one among the primary colours, and the most universally and permanently agreeable to the eye of any other: also, that as the common juice of vegetables is in general green, so that of animals is in general red; the first being, perhaps, of the third order, the last of the second. It appears to be extremely worth the time and pains of philosophers to inquire

inquire into the orders of the colours of natural bodies, in the manner proposed and begun by Sir *Isaac Newton*; and particularly to compare the changes of colour, which turn up in chemical operations, with the other changes, which happen to the subjects of the operations at the same time. Nothing seems more likely than this to be a key to the philosophy of the small parts of natural bodies, and of their mutual influences.

P R O P. LXI.

To give an Account of the Ideas generated by visible Impressions.

HERE we may make the following observations :

First, That the ideas of this sense are far more vivid and definite than those of any other; agreeably to which, the word *idea* denoted these alone in its original and most peculiar sense. Hence it is proper to make the strictest examination into the ideas of this sense, and their properties, since it is probable, from the analogies every where conspicuous in natural things, that these are patterns of all the rest. Their peculiar vividness and precision may therefore be considered as serving like a microscope in respect of other ideas, *i. e.* as magnifying their properties.

Secondly, The vividness and precision here spoken of relate chiefly to distance, magnitude, motion, figure, and position, *i. e.* to the things considered in the fifty-eighth proposition. However, colours have distinct ideas of themselves; but then they require an exertion of our voluntary powers for the most part; whereas the ideas of distances, magnitudes, &c. recur incessantly in the trains which pass over the fancy.

Thirdly, The peculiar vividness and precision of visible ideas may probably be owing to the following

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causes,

causes, as well as to some peculiar unknown structure of the optic nerve, and corresponding region of the brain; viz. the perpetual recurrency of visible objects, either the same, or similar ones, during the whole time that we are awake; the distinct manner in which they are impressed by means of the several proper conformations of the eye; and their being received in general upon the same part of the *retina*, precisely or nearly. For, when we view any object with attention, we make the central point of it fall upon the central part of the *retina*. Farther, as the optic nerve sends off no branches, but is spent wholly upon the *retina*, this may perhaps contribute in some degree. And these considerations may a little help us to conceive, how the optic nerve, and corresponding region of the brain, may be the repository of such an immense variety of visible ideas, as they are in fact.

Fourthly, The idea of every familiar object has, for the most part, some particular magnitude, position, and aggregate of associates, in its recurrences to the mind. And this somewhat lessens the difficulty mentioned in the last paragraph. The reason of this fourth observation is, that though every visible object appears under different magnitudes, in different positions, and with different associates, yet these differences destroy one another, so that the strongest particularity only remains. However changes are made from time to time, each subsisting for a short period, and then giving way to the next in succession.

Fifthly, We have fictitious visible ideas of places and persons that we have never seen, as well as of those which we have. These are derived from association evidently, and they often undergo successive changes, like those spoken of in the last paragraph.

Sixthly, Our visible ideas are subject to the voluntary power in a high degree, and may be called u

by the slightest associated circumstance, at the same time that they have very numerous connections with other ideas, and with actual impressions. The name, or its idea in the region of the brain corresponding to the ear, are the circumstances most commonly made use of for calling up visible ideas. But there are many ideas, *i. e.* internal feelings, which have no names, and which yet, by attending our several visible ideas, get this power of introducing them.

Here it is to be observed, that an idea cannot be said to be voluntarily introduced, till it be previously determined by some of its associates. If I desire to introduce a visible idea of any kind, an *individuum* *pagum*, and that of an horse offers itself, it was not owing to the command of my will, that it was an horse, and nothing else, but to the connection which the idea of an horse had with some other idea or impression, which then happened to take place. But if I desire to recollect the features of a person's face, whom I saw yesterday, I make use of his name, his dress, the place in which I saw him, or some other associated circumstance, for this purpose. And this may be called a voluntary introduction of an idea. However, the introduction of the idea of an horse, in the circumstances just described, might be termed voluntary in a different sense, if any person thought fit to denominate it so, on account of the command of the will to introduce some idea. My design here is, only to suggest to the reader the processes generally made use of in these things. It is to be observed farther, that the associated circumstance, which determines what idea shall be called up voluntarily, does, for the most part, raise it. Thus, if a person desires me to call up the idea of an horse, the very sound of the word proceeding from his mouth will do it, for most part, immediately. If not, I go back, by my memory, to the trace left by the word, and thence to the idea, or to some common

associate of both the word and idea, capable of raising the last.

Seventhly, When we have conversed much with the same visible objects, as after having been in a crowd, travelling, &c. for many hours without intermission, we may find the ideas of these objects peculiarly strong, so as to intrude upon our fancies, and interfere with all our other ideas. This may serve to shew, that the permanence of the sensations impressed, mentioned in the third proposition, and which shews itself particularly in visible impressions, as there remarked, is of the nature of an idea. And it coincides remarkably with this, that the ideas should be peculiarly vivid and precise in the same sense, where the permanency of the sensation impressed is most conspicuous.

Eighthly, The ideas of sight and hearing, and the impressions from whence they proceed, have a peculiar connection with each other. For as words pronounced call up visible ideas, so visible ideas and objects call up the ideas of words, and the actions by which they are pronounced.

Ninthly, The trains of visible ideas are in a particular manner affected by the general states of the brain, as may appear from the trains which present themselves in madness, frenzies, and common deliriums. This agrees remarkably with what has been already observed concerning the ideas of this sense; and we may infer from all together, that the regions of the brain corresponding to the optic nerve are comparatively large, or peculiarly susceptible of impressions, or both.

Tenthly, The imagery of the eye sympathizes also remarkably with the affections of the stomach. Thus the grateful impressions of opium upon the stomach raise up the ideas of gay colours, and transporting scenes, in the eye; and spasms, and indigestions, have often a contrary effect. The ghastly
face

faces which sometimes appear in idea, particularly after drinking tea, seem to be an effect of this kind, or perhaps of the last-mentioned one; for they are common to persons of irritable nervous systems. Ghastly faces may take place preferably to other disagreeable ideas, perhaps because characters, affections, passions, are principally denoted and expressed by the countenance; because faces are the most common of visible objects, and attended to with the greatest earnestness; because we criticize much upon the beauty of faces, and upon the proportion of the several features to each other; and because evil spirits (the notions of which generally take strong and early possession of our fancies) are painted with ghastly faces. This mixture of reasons hinders each particular one from being so obvious, as might otherwise be expected; however, the same thing is common in many other cases. The trains of visible ideas, which occur in dreams, are deducible, partly from the sympathy here mentioned, partly from that of the last paragraph.

Eleventhly, Our stock of visible ideas may be considered as a key to a great part of our knowledge, and a principal source of invention in poetry, painting, mathematics, mechanics, and almost every other branch of the arts and sciences. In mathematics and mechanics the invention of the diagram is, in effect, the solution of the problem. Our memories are also much assisted by our visible ideas in respect of past facts, and the preservation of the order of time depends in a particular manner upon our visible trains suggesting each other in due succession. Hence eye-witnesses generally relate in order of time, without any express design of doing so. This recollection of visible ideas, in the order in which they were impressed, gives rise to the *loci memoriales*, in which matters principally worthy of remembrance are to be repositied, and to the artificial

cial memory, that is borrowed from the eye; just as the facility of remembering words formed into verses does to the artificial memory borrowed from the ear. It may deserve notice here, that some persons have imaginary places for the natural numbers, as far as one hundred, or farther.

Twelfthly, The ideas which different persons have of the same persons faces, though they be very like one another, cannot yet be precisely the same, on account of the addition and omission of little circumstances, and a variety of associated ones, which intermix themselves here. Hence the same picture may appear much more like to one person than to another, viz, according as it resembles his idea more or less.

Thirteenthly, Painters, statuaries, anatomists, architects, &c. see at once what is intended by a picture, draught, &c. from the perfection of their visible ideas; and carry off the scene, plan, &c. in their memories, with quickness and facility. All which is still owing to association. But it would be endless to enumerate the instances of associations which this sense affords.

Fourteenthly, It is probable, that fables, parables, similes, allegory, &c. please, strike and instruct chiefly on account of the visible imagery, which they raise up in the fancy. They are also much more easily remembered on the same account. We may add, that idolatry, heathenish and popish, has made a much quicker and more extensive progress in the world on account of the stability and vividness of visible impressions and ideas, and the difficulty of obscurity, and changeable nature, of abstract notions. And image-worship seems even to have been derived in great measure from this source.

Fifteenthly, It would be a matter of great curiosity and use (as far as these speculations can be of any use) to inquire carefully into the progress of the

mind, and particularly of the fancy, in persons born blind, and compare the result with what is advanced under this proposition, and with other parts of these papers, in order to correct and improve the theory of association thereby. It is probable, that they are considerable losers, upon the whole, in respect of knowledge; though their greater degree of attention, and the superior acuteness of the senses of feeling and hearing, and consequently, perfection of the ideas of these senses, must give them some particular advantages.

P R O P. LXII.

To explain the automatic Motions, which are excited by Impressions made on the Eye.

THESE motions are of two kinds, external and internal. The external are the motions of the globe of the eye, those of the eye-lids, and the contractions of the lacrymal, and other neighbouring glands, whereby they are evacuated. The internal are the contractions of the greater and lesser muscular rings of the *iris*, of the radiated fibres of the *iris*, and of the ciliar ligaments. I will speak of each of these in order.

I begin with the motions of the globe of the eye. And here I observe, First, That the white tendinous expansions of the four strait muscles reach as far as the *cornea*; and consequently, that they are thereby exposed in a particular manner to the action of light, when the eye is open; being covered by nothing but a thin membrane. However, the tendinous expansions of the *adducens* and *abducens* are much more exposed than those of the *attollens* and *deprimens*; and, if the eye be but a little open, the light cannot fall upon these last at all.

Secondly, If a luminous object be placed upon the right side, so as that the light shall fall in a particu-

lar manner upon the tendinous expansion of the *abducens* of the right eye, and of the *adducens* of the left, it may by contracting these muscles make the eyes move in a congruous manner, turning them towards itself; and the tendency of the eyes to move towards the right side ought not to cease, till the *adducens* and *abducens* in each eye have an equal quantity of light fall upon them from the luminous object, *i. e.* till the optic axes be directed to it. In which case the eyes would be in *æquilibrio*, as far as they are under the influence of the light which falls upon the tendinous expansions of the strait muscles.

Thirdly, It agrees remarkably with the two last paragraphs, that new-born children move their eyes in a congruous manner; that the motions are chiefly to the right and left, scarce upwards and downwards at all, the eye-lids being seldom so much opened as to expose the tendinous expansions of the *attollens* and *deprimens*; and that their eyes are frequently turned towards luminous objects, such as a candle, or a window.

Fourthly, But it is not necessary, that the eyes of new-born children should always turn to the luminous object, or remain fixed upon it. For every muscle, when it has exhausted itself by contraction, gives place to its antagonist of course. If therefore the luminous object be much on one side, the eyes ought to turn back from it almost immediately. To which we may add, that various luminous objects generally affect the eyes at the same time; that the four strait muscles do naturally balance each other, and keep the eyes in a right forward position; and that the oblique muscles scarce favour any particular oblique position, though they do prepare the eye to turn with greater facility, in compliance with the contraction of any one of the four strait muscles. There are therefore sufficient sources for a variety of motions in the globes of the eyes, without destroying their congruity.

Fifthly,

Fifthly, It is worthy of attention here, that the *attollentes* and *deprimentes* do not want the same external influence of light to make them move in a congruous manner, as the *adducentes* and *abducentes*; in as much as one *adducens*, and one *abducens*, must act together to make the eyes move congruously to the right and left; whereas the two *attollentes*, and two *deprimentes*, act together in the congruous motions upwards and downwards. As far therefore as the nerves of one side sympathize with the corresponding nerves of the other in the influences which descend from the brain, there will be a natural tendency in the eyes to move upwards and downwards in a congruous manner, and to the right and left in an incongruous one. And this suits well with the greater exposition of the tendinous expansions of the *adducentes* and *abducentes* before taken notice of. For what reason so many pairs of nerves are concerned in the motions of the globe of the eye, and of the eye-lid, remains to be inquired.

Sixthly, It may perhaps be, that the light which passes in at the pupil has some efficacy in moving the globe of the eye, either by unknown communications in the brain between the optic nerve, and the third, fourth, and sixth pairs, or perhaps by penetrating in a small degree through the *retina*, *choroides*, and *sclerotica*, to the four strait muscles. If this last influence could be allowed, it would oppose that exerted upon the tendinous expansions; but would, however, join with it in preserving the congruity of the motions.

Seventhly, As the two oblique muscles neither have tendinous expansions exposed to the light, nor adhere to the globe of the eye, except just at their insertion, they cannot be under either of the influences here supposed to affect the strait muscles, but must be subject chiefly to those which descend from the brain; thus acting almost uniformly, unless in particular agitations of

of the whole nervous system. And this agrees well with the fact, and with the uses generally assigned to these muscles, viz. those of keeping the eye in a moderate suspension always, and drawing it out on eminent occasions.

Eighthly, The circumstances which occasion squinting in young children, agree well with the theory here proposed. Thus, if a child be laid so into his cradle, as that one eye shall be covered, the external influences of light cannot operate upon it. And if this be often repeated, especially while the association which confirms the congruity of the motions is weak, the eye which is covered will obey the influences which descend from the brain, and turn upwards and inwards for the most part. What turns the scale in favour of this position, remains to be inquired.

The second of the external motions is that of the eye-lids, or the actions of the *elevator*, and *orbicularis palpebrarum*. What excites the first to constant action during the whole time that the new-born child is awake, is difficult to say. | Perhaps the action of light upon the white of the eye, sending vibrations under the upper eye-lid, and thence into the fibres of the *elevator*: or the direct action of light through the skin; for it is a cutaneous muscle: or influences which descend into the third pair from the second, *i. e.* the optic nerve: or the friction from the globe of the eye in its motions, which may also make the eye-lid sympathize in motion with the eye, or the aggregate of all these. As to the *orbicularis*, it is evidently put into action by irritations affecting the eye, as from dust, flies, &c. even in adults.

The third of the external motions, or the contraction of the lacrymal, and other neighbouring glands arises from irritations in the eye, nose, *fauces*, and scalp of the head. The manner in which these irritations operate, has been sufficiently explained under

Prop. 53.

Of the internal motions I will consider the contraction of the greater and lesser rings together, as proceeding from the same causes, and being cotemporaneous; and, for the same reasons, the contraction of the radiated fibres, and ciliar ligament, together also. By the first the eye is fitted for distinct vision at small distances, by the other at great ones. Thus let us suppose a candle to be brought nearer and nearer to the child's eye. It is evident, that the quantity of light which falls upon the eye will grow greater and greater. It will therefore agitate all the circular fibres of the *iris* more powerfully, and particularly the greater and lesser rings; *i. e.* it will bend the *cornea* into a greater convexity, bring the origin of the ciliar ligament nearer to its insertion in the *capsula* of the crystalline, *i. e.* suffer the *capsula* to become more convex also, and narrow the pupil, *i. e.* lessen the *radius* of dissipation. The image of the candle upon the *retina* may therefore continue to be distinct, as it approaches, by this mechanical influence of light upon the eye. And, for the same reasons, it may continue distinct, as it recedes. But there are limits on both hands. And thus the conformations of the eye necessary for distinct vision, according to Dr. *Jurin's* most accurate account of this matter, are brought about automatically, and suitably to the general theory of these papers.

However, it is also probable, that the light which passes in at the pupil, has great efficacy in contracting both the greater and lesser rings, as may be concluded from the immobility of the pupil in a *gutta serena*; also because, on this supposition, the light, which passes in at the pupil must, by contracting the lesser ring, become a check and guard against its own too free admission, which is agreeable to the tenor of nature in like instances. The *retina* extends to the greater ring, and may send some nervous fibres to it, and even to the *iris*.

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One or both of these actions of light seem to increase the secretion and circulation of the aqueous humour in new-born children, so as to fit the eye for vision, which it is not, through the deficiency and muddiness of the aqueous humour, till some time after birth. This again may be considered as a circumstance, that favours our present conjectures.

As to the radiated fibres of the *iris*, and the ciliar ligament, they do not seem so much to be excited to action by any external influence, as to be kept in a state of constant small activity by the vibrations which descend from the brain. When therefore the rings are relaxed, the radiated fibres will open the pupil, and the ciliar ligament draw out the *capsula* of the crystalline to a flatter shape, and thus suit the eye to obscure and distant objects.

P R O P. LXIII.

To explain the Manner and Degree, in which the automatic Motions, mentioned in the last Proposition, are influenced by voluntary and semivoluntary Powers.

SINCE the motions of the eyes are in every instance congruous, from the instant of birth, an associated tendency thereto is generated sooner, and more firmly established, than perhaps in any other case. As therefore the external influence of light by growing languid, comes to have less and less effect perpetually for this purpose, so the associated tendency grows stronger and stronger; and the sum total of both may perhaps be always about equal.

However, this congruity does not seem to be so great in children as in adults, who can direct their optic axes by a perfectly voluntary power to the object which they intend to view with attention. We must examine therefore, how the almost perfect congruity becomes an entirely perfect one.

Now

Now here we are to observe, that the almost perfect congruity begets an almost perfect correspondency in the points of the *retina*, and that hence it will follow by degrees, that the least deviation from perfect congruity will occasion double vision, and confusion. But these are unpleasant and inconvenient, whereas single and distinct vision is pleasant and convenient. Whence every recurrency of the last will tend to confirm it, of the first to exclude it, from principles already laid down, *Prop. 22. Cor. 1.* The child will therefore come to a perfect congruity at last, *i. e.* to direct his optic axes precisely to the point which he intends to view. The voluntary power of suiting the internal motions to the distance must be supposed to grow perfect about the same time.

It agrees with this method of reasoning, that persons who lose the sight of one eye in their childhood or youth, though long after the external action of light has lost its efficacy for making the motions congruous, generally squint a little with that eye.

The persons who squint, preserving the sight of the squinting eye, are obliged to move their eyes in a congruous manner, for the same reason as others, *viz.* to avoid double vision, though the position be incongruous.

The constant action of the *elevator palpebrae superioris* in adults seems to be entirely from custom, *i. e.* association, being kept up in a more particular manner by the variety of visible objects, which engage our attention during the course of the day.

It is generally some time before children get the voluntary power of shutting the eyes gently, or of shutting one and not the other. They can shut them with force soon, this action recurring often from motes in the eyes, pain of any kind, &c. The procedure here is of the same kind as in other voluntary actions.

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The internal motions depend originally upon the greater or less quantity of light which falls upon the *cornea* and *iris*, as has been observed already. But the nearness and remoteness of the luminous object are the respective associates of these. The muscular rings therefore, which at first contracted only when very luminous objects approached, will afterwards contract when moderately luminous ones do. And thus vision will be made distinct in general. But distinct vision, by recurring, will perpetuate and perfect itself, and indistinct check and abolish itself, from the agreeableness and disagreeableness accompanying them respectively, by *Prop. 22. Cor. 1.* till at last the child gets a perfectly voluntary power of suiting his eyes to the distance. Adults seem to have a power of preparing the eyes previously to see at a proposed distance; and some to have a semivoluntary power of contracting and dilating the pupil, viz. by fancying a bright object near, and a dark one far off; though the quantity of light which falls upon the eye remain the same.

S E C T. V.

OF THE SENSE OF HEARING.

P R O P. LXIV.

To assign the immediate Organ of Hearing, and to explain in general the Uses of the several Parts of the external and internal Ear.

THE immediate organ of hearing appears to be the soft portion of the seventh pair of nerves distributed in the *cochlea*, and semicircular canals. What the particular uses of these cavities are, is not known. They bear some obscure likeness to the instruments commonly made use of for increasing either the loudness of sounds, or the effects of them upon the ear; just as the coats and humours of the eye resemble lenses. The auditory nerve is also like the optic in detaching no branches off to the neighbouring parts; and there are many other instances of resemblance between these two most refined and spiritual, if one may so say, of our senses; some of which I shall mention in the course of this section.

The auricle and *meatus auditorius* are cartilaginous, and seem by this means to be peculiarly fitted for receiving and retaining the vibrations of the air, and for communicating them to the *membrana tympani*.

This membrane appears to be kept in a state of constant tension by muscles, that act upon the small bones in different ways, and thus to be fitted for vibrating synchronously to the several sounds, which affect it. Agreeably to which, the degree of tension varies, so as to be less when the *musculus externus* and *obliquus* act, greater when these are relaxed, and the

the *internus* acts. The degree of sensibility both in the membrane itself, and in the whole organ, is probably greater when the tension is greater.

The vibrations of the air seem to shake off the *mucus* which lodges upon the *membrana tympani* in the new-born child, just as the action of light fits the *cornea*, and aqueous humour, for vision.

The eustachian tube serves to supply the cavity of the *tympanum* with air, to carry off the vapour which exhales into it, and perhaps to increase the effects of sounds by the tremors in its cartilaginous extremity, and particularly those of the person's own voice.

The *stapes*, its muscle, and the *foramen ovale*, seem designed to convey the vibrations of the *membrana tympani* to the auditory nerve in a precise manner. But the vibrations excited in its æther may be much more frequent than those of the *membrana tympani*, as has been already observed.

There does not appear to be any method for conveying air into the cavities of the *vestibulum*, *cochlea*, and semicircular canals, nor any necessity or use for it there. The great hardness of the bony part of the organ of hearing may make it more easily susceptible of vibrations. Agreeably to which, it may be observed, that we can hear imperfectly, though the ears, nose, and mouth, be all stopped, and consequently all access to the *membrana tympani* by the vibrations of the air denied. The vibrations are here excited probably in the cartilages of the auricle and *meatus* and in the bones of the skull, and thus communicated to the *cochlea*, and semicircular canals. It seems to agree with this, that some partially deaf persons can hear best, when driven in a coach over stone or gravel; *i. e.* when all the parts of their bodies and particularly those of the bones, are put into vibrating motion.

The bony part of the organ of hearing seems to come to its full size early in life. Is not the firm

cause of this, that one part may, on account of its size, be most disposed to vibrate with one tone, another with another? And does not this hold particularly in respect of the *lamina spiralis*? For thus the same tone would be affixed and associated to the same nerves, so as to affect them peculiarly, from childhood or youth to old age.

P R O P. LXV.

To examine how far the *Phænomena* of musical and other inarticulate Sounds are agreeable to the Doctrine of Vibrations.

HERE we may consider, first, the different strength of sounds. Now, as this arises from the different condensation of the air in the pulses, so the effect which it has upon the *membrana tympani*, the membrane of the *foramen ovale*, and the nerves of hearing, must be different likewise, and afford the mind a sufficient foundation for distinguishing sounds in respect of strength and feebleness.

Secondly, The gravity and acuteness of sounds arise from the slowness or frequency of the vibrations. Now, as the vibrations of the *membrana tympani* are synchronous to those of the air, they may either excite synchronous ones in the particles of the auditory nerves, and thus be distinguished from each other in respect of frequency by the mind; or if every pulse of the air, and oscillation of the *membrana tympani*, excite innumerable infinitesimal vibrations in the auditory nerves, the renewal of these at different intervals according to the different gravity or acuteness of the sound will, however, afford a like criterion.

It may be remarked, that grave sounds are in general strong, acute ones feeble. For the bodies which yield grave sounds are in general large, and consequently will make an impression upon the air by a large number of trembling particles.

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Thirdly,

Thirdly, All very loud noises are disagreeable. Now it is easy to conceive, that very violent agitations of the *membrana tympani* may produce the solution of continuity in the small medullary particles of the auditory nerve. An inflammation in the small vessels of the auditory nerve may render it so susceptible of violent vibrations, as to be hurt by gentle sounds, as sometimes happens in distempers; and to produce that acuteness in the sense of hearing, which answers to the *nyctalopia* in the eye.

Fourthly, Single musical, *i. e.* uniform sounds, whether vocal or instrumental, are pleasant in proportion to their loudness, provided this be not excessive. We must therefore suppose here, that the repeated impulses of the air, at equal distances, make the vibrations approach to the solution of continuity; yet still so as to fall short of it.

Fifthly, Two musical notes sounded together, suppose upon an organ or violin, afford a greater original pleasure than one, provided the ratios of their vibrations be sufficiently simple. Thus any note sounded with its eighth, fifth, fourth, third major or minor, sixth major or minor, affords pleasure, the ratios being here, respectively, those of 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 3 to 5, and 5 to 8, which are all very simple ones. But a note with its flat or sharp, second, or seventh, or flat fifth, is originally disagreeable. It may be observed also, that concords seem to be originally pleasant in proportion to the simplicity of the ratios by which they are expressed, *i. e.* in the order above set down. Hence we may perhaps suspect, that even the concords were originally unpleasant to the ear of the child, from the irregularity of the vibrations which they impress upon the *membrana tympani*, and consequent solution of continuity; and that they fell at last within the limits of pleasure, as many other pains do, by repetition. For thus those concords in which the ratios are simple

simplest would become pleasant first, and the others would continue to excite pain, or to border upon it. It is agreeable to this, that discords become at last pleasant to the ears of those that are much conversant in music, and that the too frequent recurrency of concords cloy.

Sixthly, Concords founded in succession seem to have the same effect, in kind, upon the ear, as when founded together, only less in degree. But discords in succession do not offend, unless the chromatic succession of half notes, or some such remarkable ones, and even these please at last. All this follows easily from the last paragraph; and the present paragraph, with the two last, taken together, contain the principal grounds of the natural and original pleasures of music. The pleasures which it derives from association will be considered hereafter.

P R O P. LXVI.

To examine how far the Judgments which we make concerning the Distance and Position of the sounding Body, are agreeable to the Doctrine of Association.

SOUNDS ought to decrease in the reciprocal duplicate ratio of the distance, did they not receive some support from the reflection of the bodies over which they pass. This makes them decrease in a less ratio; however, they do decrease in general with the distance; and this decrease, being an associate of the increase of distance, ought to suggest it to the imagination. And, agreeably to this, we may observe, that, when the wind opposes the sound of bells, they appear farther off; when a person calls through a speaking trumpet, he appears nearer, than at the true distance.

As to the position of the sounding body, we have no clear or certain criterion, unless it be very near

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us;

us; so as that the pulses may strike one ear, or one part of the head, considerably stronger than another. Hence we judge of the position of the speaker, or sounding body, by the eye, or by some other method independent on the ear. And thus, if from some mistaken presumption a voice, or sound, shall be deemed to come from a quarter different from the true place of it, we shall continue in that error from the strength of that mistaken presumption.

By laying these things together, and also considering farther, that indistinctness in articulate sounds is an associated mark of distance, we may see how *ventriloqui*, or persons that speak in their throats without moving their lips, impose upon the audience. Their voice is faint and indistinct, and therefore appears to come from a more distant quarter than the speaker. The hearers look about therefore, and, being surprized, their imagination fixes strongly upon that corner, or cavity, which appears most plausible; and afterwards they continue to impose upon themselves by the strength of this prejudice.

P R O P. LXVII.

To examine how far the Power of distinguishing articulate Sounds depends upon the Power of Association.

ONE may suppose the external and internal ear to be so formed, as that all the differences in the vibrations of the air, which arrive at the ear, may affect the auditory nerves with corresponding differences. Let us therefore first consider in what manner different sounds impress different vibrations upon the air.

First, then, Since not only the parts about the throat, but those of the mouth, cheeks, and even of the whole body, especially of the bones, vibra

in speaking, the figure of the vibrations impressed upon the air by the human voice will be different from that of the vibrations proceeding from a violin, flute, &c. provided the distance be not too great. This therefore may be considered as one help for distinguishing articulate sounds from all others.

Secondly, Articulation consists in breaking out from a whisper into sound, or closing the sound in different manners, the organs of speech being put also into different shapes, so as to join the differences mentioned in the last paragraph with various eruptions and interruptions, ascents and descents of sound. And thus each letter may be distinguished from every other by hearing.

Thirdly, It is agreeable to all this, that it is difficult at great distances to distinguish the tone of one musical instrument from another, or of any from the tone of a human voice, *ceteris paribus*; or to distinguish articulate sounds from one another. For at great distances the vibrations of the air are circular to sense, and all the ascents, descents, eruptions, and interruptions of sound, which distinguish one compound sound from another, are confounded by numberless reflections from the intermediate bodies.

Fourthly, We may observe, that as the preserving the distinction of place is the chief end of the coats and humours in the organ of sight, so the distinction of time is of the greatest importance in hearing. It seems probable therefore, that the *membrana tympani*, small bones, and their muscles, are so contrived, as by their actions to preserve the distinction of time, *i. e.* to extinguish strong sounds, and to keep up weak ones, so as that the last may not be too much overpowered by the continuance of the first; just as the treble notes of a harpsichord would be if the bass ones, did not the bits of cloth affixed to the

the jacks check the vibrations of the strings in due time.

Having now shewn how articulate sounds may be distinguished from one another, and from all other sounds; I next observe, that, in fact, the speakers do not pronounce so articulately and distinctly in common conversation, as to furnish the hearers with the requisite criterions according to the foregoing theory; but that we arrive at a facility of understanding one another's discourse, chiefly by the power of association.

And, first, It is needless to pronounce every letter so as to distinguish it from all others. For then words, which are composed of letters, would each have as many criterions as they have letters, and even more; for the order of the letters is a criterion, as well as the sound of each letter. In like manner, sentences would have as many compound criterions as they have words, besides the criterion arising from the particular order of the words.

Secondly, Since words are formed from combinations, not according to any rule, which brings up all the combinations of twos, threes, &c. in order, but by particular associations, agreeably to the nature of each language, since also sentences are formed in the same way, the several component parts of words and sentences suggest each other, and associate the whole words and sentences by the power of association. Thus the beginning is commonly observed to suggest the whole, both in words and sentences; and the same is true, in a less degree, of the middles and ends.

Thirdly, The subject matter of the discourse, the gestures used in speaking, a familiar acquaintance with the particular voice, pronunciation, gestures, &c. of the speaker, and other associated circumstances, contribute greatly also. And therefore on the other hand, we find it difficult to distinguish proper

proper names, and the words of an unknown language, and to understand a person that is a stranger, or that uses no action.

We may see also, that it is chiefly by the means of associated circumstances, that the sounds uttered by *ventriloqui* suggest to us the words, which they are supposed to pronounce; for their articulations must be very incomplete, as they do not move their lips at all.

It is by a like set of associated circumstances that we are enabled to read with so much facility the irregular hand-writing of various persons, and of some more than others, in proportion as we are better acquainted with the subject, language, hand-writing, &c.

P R O P. LXVIII.

The Doctrine of Sounds illustrates and favours that of the Vibrations of the small medullary Particles of the Brain, and nervous System.

FOR the theory of sounds deduced from the nature of an elastic fluid, and the tremors of the particles of sounding bodies, and afterwards verified, as it has been, by numerous experiments, becomes a guide to us in all inquiries into the vibrations of other elastic mediums, such as the æther, and into the effects, which such vibrations must impart to and receive from the small particles, that are surrounded by the elastic medium. And the general tendency which is found in natural bodies, either to yield a sound upon percussion, or at least to support and convey sounds by receiving isochronous vibrations, and reflecting them, shews, that there are latent active powers, in the small parts of bodies, which dispose them to vibrate. Now, if there be such powers in the biggest component particles, analogy inclines one to expect them in the several descending orders.

The doctrine of sounds does also furnish us with an answer to one of the principal and most obvious difficulties attending the supposition, that all sensation, thought, and motion, is performed by vibrations in the medullary substance. For it may be objected, that such a number of different vibrations, as seems to be required in certain cases, can scarce exist together in the medullary substance. Thus it is not uncommon for a person to receive a series of sensations, carry on a train of thought, and perform a course of external actions, which have little connection with each other, at the same time. Now to this we may answer, that vibrations as different from each other do, in fact, exist together in common air, in such a manner as to be perceived distinctly. Thus a person may listen to what part he pleases in a concert of music, and masters in the art can listen to more than one. They can also at the same time receive, attend to, and understand the vibrations of the air, arising from the discourse of other persons. But in whatever manner these different vibrations can exist together precisely at the same instant, or rather succeed each other at infinitesimal intervals, without confusion; in the same manner may vibrations and vibratiuncles exist together, or succeed each other, without confusion also, in the medullary substance: and by whatever power the soul is qualified to attend to, and distinguish from each other, these several vibrations of the air, by the same power may it correspond to the vibrations in the medullary substance, so that each shall have its peculiar effect of producing the appropriated sensation, thought, and motion. It is to be observed farther, that there is a difficulty in performing both the things here mentioned; that confusion does often arise; and that where any person is remarkable for doing more than one thing at once, it is in consequence of great practice, and also of exquisite mental powers, *i. e.* of an exquisite make

of the medullary substance, according to the theory of these papers.

P R O P. LXIX.

To explain in what Manner, and to what Degree, agreeable and disagreeable Sounds contribute, in the Way of Association, to the Formation of our intellectual Pleasures and Pains.

As all moderate and tolerably uniform sounds please young children, and the original pleasures from concords sounded together, from the succession of both concords and discords, and even from clear, musical sounds, considered separately, remain with us through the whole progress of life, it is evident, that many of our intellectual pleasures must be illuminated and augmented by them. And, on the contrary, harsh, irregular, and violently loud noises must add something to the disagreeableness of the objects and ideas, with which they are often associated.

The pleasures of music are composed, as has been already observed, partly of the original, corporeal pleasures of sound, and partly of associated ones. When these pleasures are arrived at tolerable perfection, and the several compounding parts cemented sufficiently by association, they are transferred back again upon a great variety of objects and ideas, and diffuse joy, good-will, anger, compassion, sorrow, melancholy, &c. upon the various scenes and events of life; and so on reciprocally without perceptible limits.

The corporeal pleasures from articulate sounds are either evanescent from the first, or, however, become so very early in life. By this means we are much better qualified to receive in formation, with mental pleasure and improvement, from them; and the ear becomes,

becomes, like the eye, a method of perception suited to the wants of a spiritual being. And indeed when we compare the imperfections of such as have never heard, with those of persons that have never seen, it appears, that the ear is of much more importance to us, considered as spiritual beings, than the eye. This is chiefly owing to the great use and necessity of words for the improvement of our knowledge, and enlargement of our affections; of which I shall have particular occasion to treat hereafter. An accurate inquiry into the mental progress of persons deprived of the advantages of language, by being born deaf, would be a still better test of the theory of these papers, than a like inquiry concerning persons born blind.

P R O P. LXX.

To give an Account of the Ideas generated by audible Impressions.

THE ideas which audible impressions leave in the region of the brain, that corresponds to the auditory nerves, are, next to the ideas of sight, the most vivid and definite of any; and all the observations above made upon the ideas of sight may be applied to those of hearing, proper changes and allowances being made. Thus, after hearing music, conversing much with the same person, in general disorders of the brain, or particular ones of the nervous system, in the stomach, after taking opium, in dreams, in madness, trains of audible ideas force themselves upon the fancy, in nearly the same manner, as trains of visible ideas do in like cases. And it may be, that in passing over words with our eye, in viewing objects, in thinking, and particularly in writing and speaking, faint miniatures of the sounds of words pass over the ear. I even suspect, that, in speaking, these miniatures are the associated circumstances which excite the action

be it voluntary, or secondarily automatic. For children learn to speak chiefly by repeating the sounds which they hear, *i. e.* these sounds are the associated circumstances, which excite to action. But if the sound does this, the idea of it must get the same power by degrees. I grant indeed, that the pictures of words in the eye, and their ideas, may be like associated circumstances, exciting to speak; and since it is necessary, according to the theory of these papers, that every semivoluntary, voluntary, and secondarily automatic action, should be excited by an associated circumstance, one may reckon words seen, and their visible ideas, amongst the number of such circumstances. But words heard, and their audible ideas, have a prior claim; and, in persons that cannot read or write, almost the only one. It confirms this, that in writing one is often apt to mis-spell in conformity with the pronunciation, as in writing *bear* for *here*; for this may proceed from the audible idea, which is the same in both cases; cannot from the visible one. Where a person mis-spells suitable to a mispronunciation, which sometimes happens, it can scarce be accounted for upon other principles. However, in writing, the associated circumstance, which excites the action of the hand, is most probably the visible idea of the word, not the audible one.

If it be objected to the supposition of these audible trains, that we ought to be conscious of them, I answer, that we are in some cases; which is an argument, that they take place in all, in a less degree; that the greater vividness of the visible trains makes us not attend to, or recollect them, till the consciousness or memory be vanished; and that even visible trains do not appear as objects of consciousness and memory, till we begin to attend to them, and watch the evanescent perceptions of our minds.

The ideas of sight and hearing together are the principal storehouse of the fancy or imagination; and

and the imaginative arts of painting and music stand in the same relation to them respectively. Poetry comprehends both by taking in language, which is the general representative of all our ideas and affections.

As there is an artificial memory relative to the eye, by which trains of visible ideas, laid up in the memory in a certain order, are made to suggest both things themselves, and the order in which we desire to remember them; so compendious trains of technical words formed into verses may be made to suggest other words, also the numeral figures in a certain order; and, by this means, to bring to view, at pleasure, the principles and materials of knowledge for meditation, inquiry, and more perfect digestion by the mind, as appears from Dr. Grey's *Memoria Technica*. The visible *loci* make a stronger impression on the fancy, and therefore excel the audible ones in that view; but the audible ones have a much more ready and definite connection with the things to be remembered; and therefore seem most proper, upon the whole, in most branches of literature. And as Dr. Grey's method is highly useful in general, so it is particularly excellent in respect of all memorables that are represented by numeral figures. For, when the numeral figures are denoted by letters, collections of them, such as dates, and quantities of all kinds, make short and definite impressions upon the ear; which are not only easy to be remembered, but also preserve the order of the figures without danger of error: whereas neither the impressions which collections of figures make upon the eye, nor those which their enunciations in words at length make upon the ear, can be remembered with facility or precision; because neither figures, nor their names, cohere together, so as that the precedent shall suggest the subsequent; as the letters do in collections of them, capable of being pronounced. When the technical

technical word coincides with, or approaches to, a familiar one, it is remembered with greater facility. Affociation is every where conspicuous in these things.

P R O P. LXXI.

To explain the automatic Motions, which are excited by Impressions made on the Ear.

It does not appear at all improbable, that the vibrations, which are excited by sounds in the cartilages of the auricle and *meatus auditorius*, should pass into the small muscles of the auricle, and there occasion automotic motions. And I guess in particular, that, in very loud sounds, the cartilages would be made to lie closer to the head. But the smallness of these muscles, and the practice of binding down the ears of new-born children close to the head, which restrains the natural action of these muscles, whatever it be, prevent our making any certain judgment

As to the four muscles which belong to the small bones, it appears to me, that since the *externus* and *obliquus* lie out of the *tympanum*, exposed to the common air, and are also so situated, that the *externus* may receive vibrations from the cartilage of the *meatus auditorius*, the *obliquus* from the cartilage of the *processus ravianus*, into which it is inserted, they must be much more affected by loud sounds, than the *internus* or *musculus stapedis*. It follows therefore, that the *membrana tympani* will be relaxed automatically by loud sounds. Here therefore is another remarkable coincidence between efficient and final causes.

For what reasons the *musculus internus*, and *musculus stapedis*, may act peculiarly in weak sounds, is difficult to say. They may perhaps, as was above conjectured of the radiated fibres of the *iris*, depend

pend chiefly on the influences which descend from the brain, and therefore act always, when the other two will give them leave. It is most probable, that the four muscles act in various proportions and combinations, so as to answer a variety of purposes. But there is very little, that is satisfactory, to be met with in books of anatomy and physiology hitherto, concerning the peculiar minute uses and functions of the several parts of the organ of hearing.

P R O P. LXXIII.

To explain the Manner and Degree, in which the automatic Motions, mentioned in the last Proposition, are influenced by voluntary and semivoluntary powers.

SINCE grave sounds are in general loud, acute ones weak, the relaxation of the *membrana tympani*, which first attends upon loud sounds automatically, will afterwards by association, be made to attend upon grave ones, even though they are not loud; and, in like manner, the membrane will be tense from acute sounds, though they should be strong; *i. e.* the membrane will, by association, be fitted to vibrate isochronously with the several tones; just as the convexity of the *cornea* is made by association to suit itself to the several distances. The accommodation is at first gross in both cases; but is perfected afterwards from the view of pleasure and convenience, by means of the frequent recurrency of the actions. See *Prop. 22. Cor. 1.*

We seem also to have a voluntary power of preparing the ear previously for very strong, or very weak sounds, which we expect to hear, just as it was before observed of the eye, that we can suit it previously to see at an expected distance. The generation of these powers is the same, as that of the other voluntary ones.

S E C T.

S E C T. VI.

OF THE DESIRES OF THE SEXES TOWARDS
EACH OTHER.

P R O P. LXXIII.

To examine how far the Desires of the Sexes towards each other are of a facitious Nature, and deducible from the Theory of these Papers.

HERE we are to observe, first, That when a general pleasurable state is introduced into the body, either by direct impressions, or by associated influences, the organs of generation must sympathize with this general state, for the same reasons as the other parts do. They must therefore be affected with vibrations in their nerves, which rise above indifference into the limits of pleasure from youth, health, grateful aliment, the pleasures of imagination, ambition, and sympathy, or any other cause, which diffuses grateful vibrations over the whole system.

Secondly, As these organs are endued with a greater degree of sensibility than the other parts, from their make, and the peculiar structure and disposition of their nerves, whatever these be, we may expect, that they should be more affected by these general pleasurable states of the nervous system than the other parts.

Thirdly, The distention of the cells of the *vesiculæ seminales*, and of the *sinuses* of the *uterus*, which take place about the time of puberty, must make these organs more particularly irritable then. It may perhaps be, that the acrimony of the urine and *faeces*, which make vivid impressions on the neighbouring parts, have also a share in increasing the irritability of the organs of generation.

Fourthly,

Fourthly, Young persons hear and read numberless things, in this degenerate and corrupt state of human life, which carry nervous influences of the pleasurable kind (be they vibrations, or any other species of motion) to the organs of generation. This will be better understood, if the reader pleases to recollect what was delivered above concerning the methods, by which we learn to distinguish the sensations of the parts external and internal from each other. For it will be easy to see, that when we are once arrived at this power, the associated circumstances of any sensations, such as the language that relates to them, will recal the ideas of these sensations.

Fifthly, The particular shame, which regards the organs of generation, may, when considered as an associated circumstance, like other pains, be so far diminished as to fall within the limits of pleasure, and add considerably to the sum total.

Sixthly, The sources here pointed out seem sufficient to account for the general desires, which are observable in young persons; and which, when not allowed and indulged, may be considered as within the confines of virtue.

Seventhly, It is usual for these desires, after some time, to fix upon a particular object, on account of the apprehended beauty of the person, or perfection of the mind, also from mutual obligations, or marks of affection, from more frequent intercourses, &c. after which these desires suggest, and are suggested by, the idea of the beloved person, and all its associates, reciprocally and indefinitely, so as in some cases to engross the whole fancy and mind. However, this particular attachment, when under proper restrictions and regulations, is not only within the confines of virtue, but often the parent of the most disinterested, and pure, and exalted kinds of it.

Eighthly, When these desires are gratified, the idea of the beloved person, and its associates, must

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now be associated with the state of neutrality and indifference, that succeeds after gratification. Whence it appears, that that part of the affection towards the beloved person, which arises from gross animal causes, cannot remain long at its height, and may fall very fast. However, if the other sources of affection grow stronger, the sum total may continue the same, or even increase.

Ninthly, When impure desires are allowed, indulged, and heightened voluntarily, it is evident from the doctrine of association, that they will draw to themselves all the other pleasures of our nature, and even by adhering to many neutral circumstances, convert them into incentives and temptations. So that all the desires, designs, and ideas of such persons are tainted with lust. However, the diseases and sufferings, bodily and mental, which this vice brings upon men, do, after some time, often check the exorbitancy of it, still in the way of association. But impure desires subsist, like vicious ones of other kinds, long after the pains outweigh the pleasures, inasmuch as they must be supposed not to begin to decline till the pains apprehended to arise from them, and thus associated with them, become equal to the pleasures.

Tenthly, It appears from the course of reasoning here used, that impure and vicious desires, indulged and heightened voluntarily, can by no means consist with a particular attachment and confinement; also that they must not only end frequently in indifference but even in hatred and abhorrence. For the proper mental sources of affection are not only wanting in these cases, but many displeasing and odious qualities and dispositions of mind must offer themselves to view by degrees.

Eleventhly, As the desires and pleasures of this kind are thus increased by associated influences from other parts of our natures, so they are reflected back

by innumerable associated methods, direct and indirect, upon the various incidents and events of life, so as to affect in secondary ways even those who have never experienced the gross corporeal gratification. And, notwithstanding the great and public mischiefs, which arise from the ungovernable desires of the vicious, there is great reason, even from this theory, to apprehend, that, if this source of the benevolent affections was cut off, all other circumstances remaining the same, mankind would become much more selfish and malicious, much more wicked and miserable, upon the whole, than they now are.

Twelfthly, I have hitherto chiefly considered how far the present subject is agreeable to the doctrine of association, but, if physicians and anatomists will compare the circumstances of the sensations and motions of these organs with the general theory delivered in the first chapter, they may see considerable evidences for sensory vibrations, for their running along membranes, and affecting the neighbouring muscles in a particular manner: they may see also, that muscular contractions, which are nearly automatic at first, become afterwards subject to the influence of ideas.

Thirteenthly, The theory here proposed for explaining the nature and growth of these desires shews in every step, how watchful every person, who desires true chastity and purity of heart, ought to be over his thoughts, his discourses, his studies, and his intercourses with the world in general, and with the other sex in particular. There is no security but in flight, in turning our minds from all the associated circumstances, and begetting a new train of thoughts and desires, by an honest, virtuous, religious attention to the duty of the time and place. To which must be added great abstinence in diet, and bodily labour, if required.

S E C T. VII.

OF OTHER MOTIONS, AUTOMATIC AND VOLUNTARY, NOT CONSIDERED IN THE FOREGOING SECTIONS OF THIS CHAPTER.

P R O P. LXXIV.

To examine how far the Motions of the Heart, ordinary and extraordinary, are agreeable to the Theory of these Papers.

HERE I observe,

First, That the motion of the heart is constant, more equable than any other in the body, and cannot be supposed to proceed from impressions made on the neighbouring parts; which things agree well together upon the supposition of the doctrine of vibrations: for thus it cannot proceed from the first or fourth source of motory vibrations; and if it proceeds from the second and third, it ought to be constant, and nearly equable.

Secondly, We are not to inquire, how the heart is first put into motion in the foetus, but only how its ordinary motions may be continued, by means of vibrations descending from the brain, after they are once begun.

Now, for this purpose, let us suppose, that the auricles, with the beginnings of the pulmonary artery and aorta, have finished their contractions; and that the ventricles and coronary vessels are full. It follows that the ventricles will now be excited to contraction by three causes, viz. by the vibrations which have continued to descend freely into their fibres, ever since their last contraction was finished, by their distention from fulness, and by the motion and impulse of the blood in the coronary vessels: but

from the moment that the ventricles begin to contract, the auricles and arteries will begin to fill, and will be fullest at the instant when their contraction is finished. The auricles and arteries must therefore begin to contract at this instant, from descending vibrations and distention, and the ventricles to be relaxed and filled, the vibrations in their fibres being checked by their past contraction. Let these actions be completed, and the heart will be in the circumstances first supposed, *i. e.* the ventricles will be ready for a fresh contraction, and so on alternately, as long as life continues.

Thirdly, The vibrations which keep up the heart's motion, are nearly allied to those arising from heat; for the second source of motory vibrations is the residue of all the vibrations excited in the various parts of the body; and the third arises chiefly from the heat of the blood. We may expect therefore, that the heart should contract either more frequently, or more strongly, or both, when the body is heated. And thus it is, as may appear from observations upon the pulse in fevers, in sleep, after eating, in pains or distempers attended with an increase of heat, &c. in which the motion of the blood is increased; whereas in nervous pains attended with coldness of the extremities, the pulse is low and slow.

Fourthly, In the declension of fevers the pulse is quick and feeble. It is feeble, because the whole body is so; and quick, partly from the new habit superinduced by the heat in the beginning of the fever; partly, because in fevers the heart is always kept nearly full, *i. e.* nearly at such a degree of distention as incites it to contraction, the principal causes of which are the weakness and inactivity of the body: hence in general the pulse is quick and feeble in persons of relaxed habits; the contrary in strong ones.

Fifthly, The pulse is quick in young and small animals; slow in old and large ones. For this, various

rious reasons may be assigned; as first, that if the velocity wherewith the sides of the heart move towards each other be the same, the contraction must be sooner accomplished in small hearts than in large ones. Secondly, that the fibres in young animals are irritable, and soon excited to contraction, by distention, &c. Thirdly, that the contraction is performed slowly in old animals; and, fourthly, that short fibres are perhaps sooner excited to contraction than long ones, it being necessary perhaps, that the vibrations should be reverberated from each end of the fibres, for many successions, before they can rise to a certain pitch. It agrees with this, that reciprocal motions are more frequent in general, and *ceteris manentibus*, as the animal is less; that the limbs have both long and short flexors and extensors, the first for great degrees of motion, the last for making a quick beginning; that the capsular ligaments of the joints have short muscular fibres inserted into them, in order to keep them from being pinched between the bones in the motions of the joints, as *Winslow* has observed; which they could not do, had not their contraction the start of the contractions which move the joint; and, lastly, that the fibres which compose the heart, are all of equal lengths, according to *Dr. Stewart's* analysis of them. See *Phil. Trans.* n. 460.

Sixthly, The heart may move incessantly without fatigue, if we only suppose the recruits to be sufficient, and the degree of motion to be within due limits. And it may be, that in labouring men the muscles of the limbs are as much exerted upon the whole as the heart. The warmth in which the heart is kept, and its receiving nerves from the eighth pair and intercostal, which seem to be particularly exempted from venal compression, deserve notice here: but the constant motion of the blood is principally to be considered, being the cause* as well as the effect of the constant motion of the heart.

Seventhly, Since lying down prevents or alleviates the fainting which sometimes happens during bleeding, one may suppose that this fainting, and the consequent abatement or cessation of the motion of the heart arise, because a quantity of blood, sufficient to keep up the vibrations in the brain, could not ascend thither in an erect posture.

Eighthly, Sudden and violent pains, such as those from wounds, increase the motion of the heart. This may be accounted for from the violent vibrations which ascend to the brain, and are thence propagated to the heart. But may not vibrations ascend also directly from the wounded part, along the course of the arteries and veins, to the heart?

Ninthly, All the passions of the mind increase the motion of the heart, as might be expected: but melancholy, when it makes men inactive, and uninfluenced by the impressions of objects, has a contrary effect, which is equally suitable to the foregoing theory.

Tenthly, In mortifications, also in the languid state that succeeds acute distempers, &c. the pulse sometimes intermits, suppose once in 5, 10, 20, &c. times, the interval being about double, and the strength of the pulse which succeeds the intermission about double also. Here the force of the heart seems to languish, and the time of contraction of the ventricle to be protracted, till a second contraction of the auricle intervenes, and protracts the ventricle's contraction still farther, viz. to nearly twice the interval. The heart must therefore be furcharged, and contracting stronger from this respite, must send, as it were, a double quantity of blood into the aorta, *i. e.* make the pulse that succeeds much stronger. And this intermission may return at greater or less intervals, according to the circumstances, while this weakness of the heart continues: it may also remain, when once established, from habit, or association.

This

This intermission may perhaps rather be accounted for thus: in languid states the blood is accumulated in the beginning of the aorta. The aorta will not therefore receive much blood from the heart, though it does contract, *i. e.* no pulse will be felt, *i. e.* the interval will be double: the succeeding pulse will be strong, from the now greater emptiness of the aorta, and fulness of the heart: the intermission will also return when the accumulation in the aorta does. It agrees with this account, that these intermissions are usually felt in the region of the heart by the patients. May not intermissions arise from both causes in different circumstances?

Eleventhly, When the pulse flutters from flatulencies and spasms in the stomach and bowels, it appears that a sudden stop is put to the blood of the aorta, which by surcharging the left ventricle at once, makes it contract at a different time from the right, and not at a due interval from the contraction of the auricles: for this fluttering of the pulse attacks generally in an instant, and often upon a fruitless effort to expel wind from the stomach. When the contractions of the ventricles are once become asynchronous and inharmonious to those of the auricles, it may require some time to rectify this, and especially while there is an impediment to the blood's motion through the aorta. This disorder may likewise continue through habit and association, and recur perpetually from less and less causes. The intermission of the pulse, considered in the two preceding paragraphs, is often caused by flatulencies, as well as the fluttering of it, mentioned in this.

Twelfthly, The motions of the heart remain in their original automatic state more than any other in the body; the reasons of which are, that the common motions are equally associated with every thing, *i. e.* peculiarly so with nothing; and that very few impressions make changes in the motions of the heart so great and sudden, as to subject it to the

ideas of the impressions: however, as great and sudden changes are sometimes brought on by pain, fear, surprize, joy, &c. we seem to have a semivoluntary power to alter the motion of the heart immediately, by introducing strong ideas, our power of introducing these being semivoluntary: nay, it may be possible for persons in very particular circumstances to acquire still greater degrees of power over the motion of the heart.

P R O P. LXXV.

To examine how far the Action of Respiration, ordinary and extraordinary, also the particular Actions of Sighing, Coughing, Laughter, Sobbing, and shedding Tears from Grief, are agreeable to the foregoing Theory.

THE first observation to be made here is, that common respiration is performed very feebly in new-born children. A slight disposition therefore to alternate action in the diaphragm, and other muscles of respiration, may be sufficient to account for that degree of respiration which takes place in new-born children. It is natural to expect, that respiration in them should be feeble, since they must lean in this, as well as in other things, to their preceding state *in utero*.

Secondly, That the vigorous impressions from the cold air, the hands of the midwife, &c. may excite the strong respiration and crying which take place upon birth ordinarily, appears from the methods used to make the new-born child respire freely, where it fails to do this in extraordinary cases; such as applying volatiles to the nose, pouring wine into the mouth, swinging it to and fro, &c. All these methods excite the muscles to contraction, by making strong impressions on the neighbouring sensory nerves.

They

They are also very agreeable to the notion of vibrations.

Thirdly, If we suppose the diaphragm to have finished its contraction, and consequently the thorax to be raised, and the abdomen to be distended, expiration must succeed, for three reasons, viz. because the contraction of the diaphragm has checked the vibrations in its fibres, and therefore has disposed them to relaxation; because the elasticity of the cartilages of the ribs tends to restore the thorax to a more depressed state; and because the fibres of the abdominal muscles are excited to vibrations and contraction by their distention. Suppose now expiration to be completed, and the vibrations, which descend into the diaphragm from the second and third source of motory vibrations, will renew its contraction, and consequently the action of inspiration; and so on alternately.

Fourthly, The diaphragm is the more disposed to receive vivid vibrations in its fibres, from its nearness to the heart, and the warmth in which it is always kept. It deserves notice here, that the diaphragm receives its nerves from the cervical pairs, not from the eighth pair and intercostal, as the neighbouring parts, the heart, stomach, &c. do. Perhaps it was requisite, that it should derive its nerves from the spinal marrow, since the other muscles of respiration do. The nerves of the diaphragm are elongated during its contraction, the contrary to which happens in the nerves of other muscles. They are also kept in constant motion by the constant motion of the thorax, through which they pass; and this perhaps may contribute to the perpetual activity of the diaphragm.

Fifthly, The intercostal muscles are disposed to alternate contractions for the same reasons as the diaphragm, though these reasons do not hold in the same degree: However, since the contraction of the diaphragm, and consequent distention of the abdomen, must

must raise the thorax, the contraction of the intercostal muscles must from the first be synchronous to that of the diaphragm; and association will soon generate a permanent disposition to this synchronism. It follows according to this theory from the vicinity of the internal intercostal muscles to the external ones, that they ought to have the same action. And the same conclusion appears to result from anatomical considerations.

Sixthly, It may however be supposed, that the diaphragm and intercostal muscles are, as it were, fatigued by constant action; and that they incline to sympathize in inactivity with the rest of the muscles, especially during sleep. But then the accumulation of blood in the lungs, which the intermission of respiration must occasion, after it has once had a free passage through the lungs, by means of respiration, will produce so much uneasiness, *i. e.* such vigorous vibrations, in the lungs, and particularly in their external membrane, which is continuous to the pleura, as will renew respiration.

It is agreeable to this, that if very young children sleep upon a bed, they often fall into a great uneasiness from the stoppage of respiration, and recover from it by crying; and that rocking, or any other gentle motion, will prevent this. The last circumstance is particularly favourable to the notion of vibrations.

The night-mare in adults appears to be a disorder of the same kind. A full supper, and lying upon the back, dispose to it, by hindering the free motion of the diaphragm. Motion, and especially when attended with quick respiration, laughter, &c. prevent it by giving activity to the diaphragm. Shaking the person affected, calling to him, &c. rouse from it, by exciting vibrations. The uneasiness from accumulated blood does the same thing at last.

It is easy to see, that if a like disposition to inaction should arise in the hearts of new-born children, or

adults

adults, the motion and distending force of the venal blood must renew their action for similar reasons. It is remarkably coincident with this, that forcing the venal blood upon the heart has in some cases been found to renew its action even after death.

Seventhly, The actions of sighing, crying, coughing, sneezing, &c. by recurring frequently, and making all the muscles, which can in any degree contribute to respiration, unite therein, enlarge the range of respiration by degrees, and make this action be performed with greater strength perpetually in the young child. The increase of strength in the whole muscular system must however be considered likewise.

Eighthly, The same actions have also a great share in begetting voluntary respiration. For more muscles are put into action in voluntary respiration, than in that which is ordinary.

Ninthly, it is agreeable to the foregoing theory, and to parallel observations on the heart, that respiration should be stronger in fevers, in sleep, and in general wherever the heat of the blood is increased, than in ordinary cases. For respiration depends chiefly on the second and third sources of motory vibrations. By this means the force of the respirations answers in a general way, as it ought to do, to the force with which the blood is moved, or to the force of the heart.

I now come to the particular consideration of the actions of sighing, coughing, laughter, and sobbing, and shedding tears from grief.

Sighing is an extraordinary contraction of the diaphragm. It arises not only from all causes, which accumulate the blood in the lungs, and thus excite the diaphragm to an extraordinary contraction; but also from such compressions of the *abdomen* as hinder the free motion of the diaphragm for a time. For thus a disposition to vibrate is accumulated in the fibres of the diaphragm. It is however to be observed, that this

this compression of the *abdomen* does also accumulate blood in the lungs. The *abdomen* seems to be compressed in a state of sorrow, attention, &c. The frequent recurrency of sighing makes it voluntary early in youth. But it is not performed voluntarily with the same force, as when from a pressing uneasiness in the lungs.

Coughing arises from an uneasy sensation in the wind-pipe fixing in the point of the *epiglottis*, as the sensation which causes sneezing does in the tip of the nose. This ought also to become voluntary, and to be weaker when voluntary, than when excited by a strong irritation.

Hawking is a voluntary action, derived from coughing, as blowing the nose is from sneezing. Spitting is nearly related to these actions. It tallies perfectly with the foregoing theory, that children cannot hawk, spit, or blow the nose, for some years.

Laughter is a nascent cry, recurring again and again, as has been observed before, *Prop.* 26. By degrees it puts on a certain type, and recurs again and again according to that type, just as other actions. And it is excited in young children not only by the sensation of tickling, which lies, as it were, between pleasure and pain, but by the apprehension of this, or any other apprehension sufficiently moderate, by every surprize, and every mental emotion that lies between pleasure and pain, and by all the associates of these, as particularly by seeing others laugh. And thus children laugh more and more, and get a power of performing the action of laughter at pleasure, though with less force than when it is excited by its proper cause in full vigour.

It is remarkable, that young brute creatures, in their sportings with each other, make such noises, as bear the same analogy to their violent cries, which laughter in us bears to crying from pain.

Bodily

Bodily pain is attended with violent and irregular respiration on account of the violent and irregular vibrations, which, in this case, first ascend to the brain, and then descend into the diaphragm. Hence mental pain, which is the offspring of bodily pain, is attended also with violent and irregular respiration, *i. e.* with sobbing. The crying which used to attend bodily pain in childhood is often checked in the mental pain of adults by fear, shame, &c. *i. e.* by a voluntary or semivoluntary power; and this seems to make the respiration so much the more irregular.

It is more difficult to account for the shedding tears from grief; for very young children are not apt to shed tears when they cry. It seems to me, that so great and general a disorder in the brain, as that which takes place in violent grief, must affect the fifth pair of nerves in a particular manner, so as to influence the lachrymal glands both directly, and also indirectly, *viz.* by the strong convulsions produced in the muscles of the eyes and face. The membrane of the *fauces* and nose are likewise affected in grief, as is evident from the sensations in the *fauces*, and tip of the nose; and thus vibrations may run to the lachrymal glands through the *ductus nasum*, and lachrymal points, as observed before in irritations from sternutatories, &c. Young children may not shed tears freely, because very great and general disorders of the brain, and its influence over the fifth pair of nerves, do not take place till intellectual aggregates are formed. And the like reason may hold in respect of brutes.

The actions of sobbing and weeping are therefore, in part, deducible from association, *i. e.* are not merely automatic, in the first sense of that word. Agreeably to which, they are in certain cases manifestly subject to the voluntary power. Thus, some persons can, by introducing imaginary scenes of compassion

passion and sorrow, so far agitate the brain, as to bring on the actions of sobbing and weeping though not in the same degree, as when they arise from a strong real mental cause. They may likewise be caught by infection, from others, as laughter, and most of our other semivoluntary and voluntary actions, are; which is another argument of their dependence on association.

P R O P. LXXVI.

To examine how far convulsive Motions of various Kinds, and the Actions of Yawning and Stretching in particular, are agreeable to the foregoing Theory.

SINCE strong vibrations must, according to the foregoing theory, descend at once into the whole muscular system in general convulsions, we must seek for a cause of sufficient extent for this purpose. Now there seem to be three kinds of vibrations which may answer this condition: first, violent vibrations in the brain. Secondly, violent ones at the skin, suddenly checked. Thirdly, violent ones at the bowels or *uterus*, suddenly checked also, and thence running instantaneously over the whole nervous system by means of the intercostal, or as *Winflow* justly calls it, the great sympathetic nerve.

Convulsions from compressions and inflammation of the brain, and most of those which are termed epileptic, seem to be of the first kind. In epilepsies the irregular vibrations, excited in the medullary substance of the brain are perhaps so violent, as first to make the small particles attract each other, and thus, by checking themselves, to extinguish all sense and motion. However, they may return after a short time, and descend into the whole muscular system.

The stretchings and yawnings which happen in ague-fits, in going to sleep and waking, the startings to which some persons are subject in going to sleep, and the convulsive tremors, and rigidity in ague-fits, seem to be of the second kind, or to arise from a sudden check of vibrations at the skin. For in agues the surface is chilled, as it is also by the least motions in going to sleep, or waking. Agreeably to this, it may be observed, that, upon stepping into a cold bed, one is disposed to general convulsions, like those of stretching. Yawning may also depend in part upon a like check of violent vibrations in the mouth and *fauces*; for it is a motion excited in the neighbourhood, and is observed to accompany sickness.

The startings and convulsions which happen to children from gripes, to women from disorders of the *uterus*, and to all persons in general from certain poisons, seem to be of the third kind, or to arise from vigorous vibrations in the *abdomen*, suddenly checked, and running into the whole system by means of the intercostal nerve.

It has been observed already, that convulsive motions are apt to return from less and less causes perpetually, on account of the vestiges which they leave of themselves, and the power of associated circumstances. I will add here, that seeing a person in convulsions is apt to occasion them in such as are of nervous and irritable frames; and that there is reason to believe, that some persons, who have been enthusiasts or impostors, have been able to throw themselves into convulsions by a semivoluntary power, and particularly, as it seems, by introducing strong ideas, and internal feelings.

It is commonly observed, that yawning is apt to infect a whole company, after one person in it has set the example; which is a manifest instance of the influence of association over motions originally automatic.

P R O P. LXXVII.

To examine how far the Motions, that are most perfectly voluntary, such as those of Walking, Handling, and Speaking, with the voluntary Power of suspending them, and their being formed according to Patterns set by those with whom we converse, are agreeable to the foregoing Theory.

It was necessary to deliver many things which properly relate to this proposition under the twenty-first, in order to make the derivation of voluntary motion from automatic, by means of association, in some measure intelligible to the reader. I will now resume the subject, and add what I am able for the full explication and establishment of the theory proposed.

Walking is the most simple of the three kinds of voluntary motion here mentioned, being common to the brute creation with man, whereas handling and speaking are, in a manner, peculiar to him. His superiority in this respect, when compared with the superiority of his mental faculties, agrees well with the hypothesis here advanced concerning handling and speaking, viz. their dependence on ideas, and the power of association.

The new-born child is unable to walk on account of the want of strength to support his body, as well as of complex and decomplex motory vibratiuncles, generated by association, and depending upon sensation and ideas by association also. As he gets strength he advances likewise in the number and variety of compound motions of the limbs, their species being determined by the nature of the articulations, the position of the muscles, the automatic motions excited by friction, accidental flexures and extension

mad

made by the nurse, &c. When he is tolerably perfect in these rudiments of walking, the view of a favourite plaything will excite various motions in the limbs; and thus if he be set upon his legs, and his body carried forward by the nurse, an imperfect attempt to walk follows of course. It is made more perfect gradually by his improvement in the rudiments, by the nurse's moving his legs alternately in the proper manner, by his desire of going up to persons, playthings, &c. and thence repeating the process which has succeeded (for he makes innumerable trials, both successful and unsuccessful); and by his seeing others walk, and endeavouring to imitate them.

It deserves notice here, that in the limbs, where the motions are most perfectly voluntary, all the muscles have antagonists, and often such as are of nearly equal strength with themselves; also, that the muscles of the limbs are not much influenced at first by common impressions made on the skin, and scarce at all when the child is so far advanced as to get a voluntary power over them. For these things facilitate the generation of the voluntary power, by making the muscles of the limbs chiefly dependent on the vibrations which descend from the brain, and also disposing them to act from a small balance in favour of this or that set of antagonists.

When the child can walk up to an object that he desires to walk up to, the action may be termed voluntary, *i. e.* the use of language will then justify this appellation. But it appears from the reasoning here used, that this kind and degree of voluntary power over his motions is generated by proper combinations and associations of the automatic motions, agreeably to the corollaries of the twentieth proposition. Voluntary powers may therefore result from association, as is asserted in these papers.

When he is arrived at such a perfection in walking, as to walk readily upon being desired by another

ther person, the action is esteemed still more voluntary. One reason of which is, that the child, in some cases, does not walk when desired, whilst yet the circumstances are apparently the same as when he does. For here the unapparent cause of walking, or not walking, is *will*. However, it follows from this theory, that all this is still owing to association, or to something equally suitable to the foregoing theory; *e. g.* to the then present strength or weakness of the association of the words of the command with the action of walking, to its proceeding from this or that person, in this or that manner, to the child's being in an active or inactive state, attentive or inattentive, disposed by other circumstances to move as directed, or to move in a different way, &c. A careful observation of the fact will always shew, as far as is reasonable to be expected in so nice a matter, that when children do different things, the real circumstances, natural or associated, are proportionably different, and that the state of mind called *will* depends upon this difference. This degree of voluntary power is therefore, in like manner, of an acquired nature.

Suppose an adult to walk, in order to shew his perfectly voluntary power; still his selecting this instance is owing to one association, and his performing the action to another, *viz.* to the introduction of the audible idea of the word, the visible one of the action, &c.

Walking passes into the secondarily automatic state more perfectly perhaps, than any other action; for adults seldom exert any degree of volition here sufficient to affect the power of consciousness or memory for the least perceptible moment of time. Now this transition of walking, from its voluntary to its secondarily automatic state, must be acknowledged by all to proceed merely from association. And it seems to follow by parity of reason, that the transition

tion of primarily automatic actions into voluntary ones may be merely from association also, since it is evident, that association has at least a very great and extensive influence there.

The complex artificial motions of the lower limbs, used in the several kinds of dancing, bear nearly the same relation to the common motions used in walking forwards, backwards, upwards, downwards, and sideways, as these common motions do to the simple rudiments above-mentioned, such as the flexion and extension of the ankle or knee. Since therefore the voluntary and secondarily automatic power of dancing are plainly the result of association, why may we not suppose the same of the common motions in walking, both in their voluntary and secondarily automatic state? In learning to dance, the scholar desires to look at his feet and legs, in order to judge by seeing, when they are in a proper position. By degrees he learns to judge of this by feeling; but the visible idea left partly by the view of his master's motions, partly by that of his own, seems to be the chief associated circumstance, that introduces the proper motions. By farther degrees these are connected with each other, with the music, and with other more and more remote circumstances.

I have already shewn, in what manner children learn the voluntary and secondarily automatic power of grasping. How they learn the various complex motions, by which they feed and dress themselves, &c. also how children and adults learn to write, to practise manual arts, &c. and in what senses and degrees all these actions are voluntary, and secondarily automatic, and yet still remain as purely mechanical, as the primarily automatic actions are, may now be understood from what has been already delivered under this proposition. The method of playing upon musical instruments has also been explained, so as to contribute in establishing the same conclusions.

In like manner, the account given of the action of speaking might now be completed, and extended to all the modes of it, vulgar and artificial; and to singing, with its modes. I will add a few words concerning stammering, and the loss of speech by palsies.

Stammering seems generally to arise from fear, eagerness, or some violent passion, which prevents the child's articulating rightly, by the confusion which it makes in the vibrations that descend into the muscular system; so that, finding himself wrong, he attempts again and again, till he hits upon the true sound. It does not begin therefore in general, till children are of an age to distinguish right from wrong in respect of pronunciation, and to articulate with tolerable propriety. A nervous disorder of the muscles of speech may have a like effect. When the trick of stammering has once begun to take place in a few words, it will extend itself to more and more from very slight resemblances, and particularly to all the first words of sentences, because there the organs pass in an instant from inactivity to action; whereas the subsequent parts of words and sentences may follow the foregoing from association; just as, in repeating *memoriter*, one is most apt to hesitate at the first word in each sentence.

A defect of memory from passion, natural weakness, &c. so that the proper word does not occur readily, occasions stammering also. And, like all other modes of speaking, it is caught, in some cases by imitation.

A palsy of the organs of speech may be occasioned in the same manner as any other palsy; and yet the muscles of the lips, cheeks, tongue, and *faucibus*, may still continue to perform the actions of mastication and deglutition sufficiently well, because these actions are simpler than that of speech, and are also excited by sensations, which have an original influence over them.

A defect

A defect of memory may also destroy the power of speaking, in great measure, though the organs be not much affected in a paralytical way. Thus a person who plays well upon a harpsichord, may by some years disuse become unable to play at all, though the muscles of his hands be in a perfect state, merely because his memory, and the associations of the motions of his fingers with the sight of notes, with the ideas of sounds, or with one another, are obliterated by distance of time, and disuse.

The suspension of an action may be performed two ways, as before-mentioned, viz. either by putting the muscles concerned in it into a languid inactive state, or by making the antagonists act with vigour. In the first case, the whole limb is put into a state of relaxation, and extreme flexibility; in the last, into a state of rigidity. The voluntary power of the first kind is obtained by associations with the languor that arises from fatigue, heat, sleepiness, &c. that of the last from the general tension of the muscles, which happens in pain, and violent emotions of mind. Children improve in both these kinds of voluntary power by repeated trials, as occasion requires, by imitation, desire, &c. But they are both difficult for some time. Thus we may observe, that children cannot let their heads or eye-lids fall from their mere weight, nor stop themselves in running or striking, till a considerable time after they can raise the head, or bend it, open the eyes, or shut them, run or strike by a voluntary power.

Imitation is a great source of the voluntary power, and makes all the several modes of walking, handling, and speaking, conformable to those of the age and nation in which a person lives in general, and to those of the persons with whom he converses in particular. Besides the two sources already mentioned, *Prop.* 21. viz. the sight of the child's own actions,

and the sound of his own words, it has many others. Some of these are the resemblance which children observe between their own bodies, with all the functions of them, and those of others; the pleasures which they experience in and by means of all motions, *i. e.* imitations; the directions and encouragements given to them upon this head; the high opinions which they form, of the power and happiness of adults; and their consequent desire to resemble them in these, and in all their associates. Imitation begins in the several kinds of voluntary actions about the same time, and increases not only by the sources alleged, but also by the mutual influences of every instance of it over every other, so that the velocity of its growth is greatly accelerated for some time. It is of the highest use to children in their attainment of accomplishments, bodily and mental. And thus every thing, to which mankind have a natural tendency, is learnt much sooner in society, than the mere natural tendency would beget it; and many things are learnt so early, and fixed so deeply, as to appear parts of our nature, though they be mere derivatives and acquisitions.

It is remarkable, that apes, whose bodies resemble the human body, more than those of any other brute creature, and whose intellects also approach nearer to ours, which last circumstance may, I suppose, have some connection with the first, should likewise resemble us so much in the faculty of imitation. Their aptness in handling is plainly the result of the shape and make of their fore legs, and their intellects together, as in us. Their peculiar chattering may perhaps be some attempt towards speech, to which they cannot attain, partly from the defect in the organs, partly, and that chiefly, from the narrowness of their memories, apprehensions, and associations; for they seem not to understand words to
any

any considerable degree. Or may not their chattering be an imitation of laughter.

Parrots appear to have far less intellect than apes, but a more distinguishing ear, and, like other birds, a much greater command of the muscles of the throat. Their talk seems to be almost devoid of all proper connection with ideas. However, in respect of sounds, they imitate as much as children, or as apes in respect of other actions. And indeed the talk of children, by out-running their understandings in many things, very much resembles that of parrots.

As we express our inward sentiments by words, so we do also by gestures, and particularly by the muscles of the face. Here, again, association and imitation display themselves. This dumb shew prevails more in the hotter climates, where the passions are more impetuous, than in these northern ones. It is also probable, that the narrowness and imperfection of the ancient languages made it more necessary and prevalent in ancient times. Deaf persons have an extraordinary aptness both in learning and decyphering this, as might well be expected. The imitation of manners and characters by dumb shew is often more striking, than any verbal description of them.

S E C T. VIII.

OF THE RELATION WHICH THE FOREGOING THEORY BEARS TO THE ART OF PHYSIC.

P R O P. LXXVIII.

The Art of Physic affords many proper Tests of the Doctrines of Vibrations and Association; and may receive considerable Improvement from them, if they be true.

THIS proposition may appear from several hints to that purpose, which have been already given.

But it will be more fully manifest, if I give a short view of the *data* and *quæsitæ* in the art of physic.

Now the general problem, which comprehends the whole art, is,

Having the symptoms given, to find the remedy.

This problem may be solved in some cases empirically and directly by the histories of distempers, and of their cures. But then there are other cases, and those not a few, to which the learning and experience of the most able physicians either cannot find histories sufficiently similar, or none where the event was successful. Hence it is necessary to attempt the solution of the general problem rationally and indirectly, by dividing it into the two following less comprehensive and consequently more manageable problems, viz.

First, *Having the symptoms given, to find the deviation of the body from its natural state.*

Secondly, *Having this deviation given, to find the remedy.*

It

It is proper also to invert these two problems, and to inquire, first, *Having the deviation given, what the symptoms must be.*

Secondly, *Having the manner of operation of a successful remedy given, what the deviation must be.*

I here use the words *symptoms, deviation, and remedy*, in the most general sense possible, for the sake of brevity.

Now it is very evident, that the doctrine of vibrations, or some other better doctrine, which teaches the law of action of the nervous system, has a close connection with all these last four problems. For the nerves enter every part, as well as the blood vessels; and the brain has as great a share in all the natural functions of the parts, and its disorders, in all their disorders, as the heart, and its disorders, can have; and much more than any other part, besides the heart.

Farther, If the doctrine of association be the necessary consequence of the doctrine of vibrations, in any such manner as I have proposed above, *Prop. 9. and 11.* it must have a most intimate connection with the theory of nervous distempers, and some with that of others, on account of the just mentioned dependence of all the parts on the brain. Or, if we separate these doctrines, still, if that of association be true, of which I suppose there is no doubt, it cannot but be of great use for explaining those distempers in which the mind is affected.

And it seems to me, that, agreeably to this, the distempers of the head, spasmodic ones, the effects of poisonous bites and stings, which, as Dr *Mead* justly observes, are more exerted upon the nerves than on the blood, receive much light from the doctrine of vibrations, and, in return, confirm it; and that all the disorders of the memory, fancy, and mind, do the same in respect of the doctrine of association.

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I do not mean to intimate here, that the rational and indirect solution of the general problem, which comprehends the art of physic, is preferable to the empirical and direct one, where this is to be had; but only, since this cannot be had always, that we ought to proceed in an explicit and scientific manner, rather than in a confused and popular one. For where practice is silent, physicians must and will have recourse to some theory, good or bad. And if they do not acquaint themselves with the real structure and functions of the parts, with the sensible qualities and operations of medicines, and with the most probable method of explaining both the symptoms of distempers, and the operations of medicines, they must fancy something in the place of these, and reason from such false imaginations, or perhaps from the mere agreements, oppositions, and secondary ideas, of words. The history of diseases, and their cures, is the basis of all; after this come anatomical examinations of the body, both in its natural and morbid states; and, last of all, pharmacy; these three answering respectively to the general problem, and the two subordinate ones above-mentioned. And if we reason at all upon the functions and disorders of the parts, and the effects of medicines upon the body, so important an organ as the brain must not be left out entirely.

It may not be amiss to add here, that as all the natural functions tend to the welfare of the body, so there is a remarkable tendency in all the disorders of the body to rectify themselves. These two tendencies, taken together, make what is called nature by physicians; and the several instances of them, with their limits, dangers, ill consequences, and deviations in particular cases, deserve the highest attention from physicians, that so they may neither interrupt a favourable crisis, nor concur with a fatal one. *Stahl* and his followers suppose, that these tendencies arise from

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from a rational agent presiding over the fabric of the body, and producing effects, that are not subject to the laws of mechanism. But this is *gratis dictum*; and the plain traces of mechanism, which appear in so many instances, natural and morbid, are highly unfavourable to it. And all the evidences for the mechanical nature of the body or mind are so many encouragements to study them faithfully and diligently, since what is mechanical *may* both be understood and remedied.

C H A P. III.

Containing a particular APPLICATION of the foregoing THEORY to the PHÆNOMENA of IDEAS, or of UNDERSTANDING, AFFECTION, MEMORY, and IMAGINATION.

S E C T. I.

OF WORDS, AND THE IDEAS ASSOCIATED WITH THEM.

P R O P. LXXIX.

Words and Phrases must excite Ideas in us by Association, and they excite Ideas in us by no other Means.

WORDS may be considered in four lights.

First, As impressions made upon the ear.

Secondly, As the actions of the organs of speech.

Thirdly, As impressions made upon the eye by characters.

Fourthly, As the actions of the hand in writing.

We learn the use of them in the order here set down. For children first get an imperfect knowledge of the meaning of the words of others; then learn to speak themselves; then to read; and, lastly, to write.

Now

Now it is evident, that in the first of these ways many sensible impressions, and internal feelings, are associated with particular words and phrases, so as to give these the power of raising the corresponding ideas; and that the three following ways increase and improve this power, with some additions to and variations of the ideas. The second is the reverse of the first, and the fourth of the third. The first ascertains the ideas belonging to words and phrases in a gross manner, according to their usage in common life. The second fixes this, and makes it ready and accurate; having the same use here as the solution of the inverse problem has in other cases in respect of the direct one. The third has the same effect as the second; and also extends the ideas and significations of words and phrases, by new associations; and particularly by associations with other words, as in definitions, descriptions, &c. The advancement of the arts and sciences is chiefly carried on by the new significations given to words in this third way. The fourth, by converting the reader into a writer, helps him to be expert in distinguishing, quick in recollecting, and faithful in retaining, these new significations of words, being the inverse of the third method, as just now remarked. The reader will easily see, that the action of the hand is not an essential in this fourth method. Composition by persons born blind has nearly the same effect. I mention it as being the common attendant upon composition, as having a considerable use deducible from association, and as making the analogy between the four methods more conspicuous and complete.

This may suffice, for the present, to prove the first part of the proposition, viz. that words and phrases must excite ideas in us by association. The second part, or that they excite ideas in us by no other means, may appear at the same time, as it may be found upon reflection

reflection and examination, that all the ideas which any word does excite are deducible from some of the four sources above-mentioned, most commonly from the first or third.

It may appear also from the instances of the words of unknown languages, terms of art not yet explained, barbarous words, &c. of which we either have no ideas, or only such as some fancied resemblance, or prior association, suggests.

It is highly worthy of remark here, that articulate sounds are by their variety, number, and ready use, particularly suited to signify and suggest, by association, both our simple ideas, and the complex ones formed from them, according to the twelfth proposition.

COR. It follows from this proposition, that the arts of logic, and rational grammar, depend entirely on the doctrine of association. For logic, considered as the art of thinking or reasoning, treats only of such ideas as are annexed to words; and, as the art of discoursing, it teaches the proper use of words in a general way, as grammar does in a more minute and particular one.

P R O P. LXXX.

To describe the Manner in which Ideas are associated with Words, beginning from Childhood.

THIS may be done by applying the doctrine of association, as laid down in the first chapter, to words considered in the four lights mentioned under the last proposition.

First, then, The association of the names of visible objects, with the impressions which these objects make upon the eye, seems to take place more early than any other, and to be effected in the following manner:

manner: the name of the visible object, the nurse, for instance, is pronounced and repeated by the attendants to the child, more frequently when his eye is fixed upon the nurse, than when upon other objects, and much more so than when upon any particular one. The word *nurse* is also sounded in an emphatical manner, when the child's eye is directed to the nurse with earnestness and desire. The association therefore of the sound *nurse*, with the picture of the nurse upon the *retina*, will be far stronger than that with any other visible impression, and thus overpower all the other accidental associations, which will also themselves contribute to the same end by opposing one another. And when the child has gained so much voluntary power over his motions, as to direct his head and eyes towards the nurse upon hearing her name, this process will go on with an accelerated velocity. And thus, at last, the word will excite the visible idea readily and certainly.

The same association of the picture of the nurse in the eye with the sound *nurse* will, by degrees, overpower all the accidental associations of this picture with other words, and be so firmly cemented at last, that the picture will excite the audible idea of the word. But this is not to our present purpose. I mention it here as taking place at the same time with the foregoing process, and contributing to illustrate and confirm it. Both together afford a complete instance for the tenth and eleventh propositions, *i. e.* they shew, that when the impressions *A* and *B* are sufficiently associated, *A* impressed alone will excite *b*, *B* impressed alone will excite *a*.

Secondly, This association of words with visible appearances, being made under many particular circumstances, must affect the visible ideas with a like particularity. Thus the nurse's dress, and the situation of the fire in the child's nursery, make part of the child's ideas of his nurse and fire. But then

then as the nurse often changes her dress, and the child often sees a fire in a different place, and surrounded by different visible objects, these opposite associations must be less strong, than the part which is common to them all; and consequently we may suppose, that while his idea of that part which is common, and which we may call essential, continues the same, that of the particularities, circumstances, and adjuncts, varies. For he cannot have any idea, but with some particularities in the non-essentials.

Thirdly, When the visible objects impress other vivid sensations besides those of sight, such as grateful or ungrateful tastes, smells, warmth or coldness, with sufficient frequency, it follows from the foregoing theory, that these sensations must leave traces, or ideas, which will be associated with the names of the objects, so as to depend upon them. Thus an idea, or nascent perception, of the sweetness of the nurse's milk will rise up in that part of the child's brain which corresponds to the nerves of taste, upon his hearing her name. And hence the whole idea belonging to the word *nurse* now begins to be complex, as consisting of a visible idea, and an idea of taste. And these two ideas will be associated together, not only because the word raises them both, but also because the original sensations are. The strongest may therefore assist in raising the weakest. Now, in common cases, the visible idea is strongest, or occurs most readily at least; but, in the present instance, it seems to be otherwise. We might proceed in like manner to shew the generation of ideas more and more complex, and the various ways by which their parts are cemented together, and all made to depend on the respective names of the visible objects. But what has been said may suffice to shew what ideas the names of visible objects, proper and appellative, raise in us.

Fourthly,

Fourthly, We must, however, observe, in respect of appellatives, that sometimes the idea is the common compound result of all the sensible impressions received from the several objects comprised under the general appellation; sometimes the particular idea of some one of these, in great measure at least, viz. when the impressions arising from some one are more novel, frequent, and vivid, than those from the rest.

Fifthly, The words denoting sensible qualities, whether substantive or adjective, such as *whiteness*, *whiteness*, &c. get their ideas in a manner which will be easily understood from what has been already delivered. Thus the word *white*, being associated with the visible appearances of milk, linen, paper, gets a stable power of exciting the idea of what is common to all, and a variable one in respect of the particularities, circumstances, and adjuncts. And so of other sensible qualities.

Sixthly, The names of visible actions, as walking, striking, &c. raise the proper visible ideas by a like process. Other ideas may likewise adhere in certain cases, as in those of tasting, feeling, speaking, &c. Sensible perceptions, in which no visible action is concerned, as hearing, may also leave ideas dependent on words. However, some visible ideas generally intermix themselves here. These actions and perceptions are generally denoted by verbs, though sometimes by substantives.

And we may now see in what manner ideas are associated with nouns, proper and appellative, substantive and adjective, and with verbs, supposing that they denote sensible things only. Pronouns and particles remain to be considered. Now, in order to know their ideas and uses, we must observe,

Seventhly, That as children may learn to read words not only in an elementary way, viz. by learning the letters and syllables of which they are composed, but also in a summary one, viz. by associating

the sound of entire words, with their pictures, in the eye; and must, in some cases, be taught in the last way, *i. e.* wheresoever the sound of the word deviates from that of its elements; so both children and adults learn the ideas belonging to whole sentences many times in a summary way, and not by adding together the ideas of the several words in the sentence. And wherever words occur, which, separately taken, have no proper ideas, their use can be learnt in no other way but this. Now pronouns and particles, and many other words, are of this kind. They answer, in some measure, to x , y , and z , or the unknown quantities in algebra, being determinable and decypherable, as one may say, only by means of the known words with which they are joined.

Thus *I walk* is associated at different times with the same visible impression as *nurse walks*, *brother walks*, &c. and therefore can suggest nothing permanently for a long time but the action of walking. However the pronoun *I*, in this and innumerable other short sentences, being always associated with the person speaking, as *thou* is with the person spoken to, and *he* with the person spoken of, the frequent recurrency of this teaches the child the use of the pronouns, *i. e.* teaches him what difference he is to expect in his sensible impressions according as this or that pronoun is used; the infinite number of instances, as one may say, making up for the infinitely small quantity of information, which each singly taken, conveys.

In like manner, different particles, *i. e.* adverbs, conjunctions, and prepositions, being used in sentences, where the substantives, adjectives, and verbs are the same, and the same particles, where these are different, in an endless recurrency, teach children the use of the particles in a gross general way. For it may be observed, that children are much at a loss for the true use of the pronouns and particles

for some years, and that they often repeat the proper name of the person instead of the pronoun; which confirms the foregoing reasoning. Some of the inferior parts or particles of speech make scarce any alteration in the sense of the sentence, and therefore are called expletives. The several terminations of the *Greek* and *Latin* nouns and verbs are of the nature of pronouns and particles.

Eighthly, The attempts which children make to express their own wants, perceptions, pains, &c. in words, and the corrections and suggestions of the attendants, are of the greatest use in all the steps that we have hitherto considered, and especially in the last, regarding the pronouns and particles.

Ninthly, Learning to read helps children much in the same respects; especially as it teaches them to separate sentences into the several words which compound them; which those who cannot read are scarce able to do, even when arrived at adult age.

Thus we may see, how children and others are enabled to understand a continued discourse relating to sensible impressions only, and how the words in passing over the ear must raise up trains of visible and other ideas by the power of association. Our next inquiry must be concerning the words that denote either intellectual things, or collections of other words.

Tenthly, The words, that relate to the several passions of love, hatred, hope, fear, anger, &c. being applied to the child at the times when he is under the influence of these passions, get the power of raising the miniatures or ideas of these passions, and also of the usual associated circumstances. The application of the same words to others helps also to annex the ideas of the associated circumstances to them, and even of the passions themselves, both from the infectiousness of our natures, and from the power of associated circumstances to raise the passions. How-

ever, it is to be noted, that the words denoting the passions do not, for the most part, raise up in us any degree of the passions themselves, but only the ideas of the associated circumstances. We are supposed to understand the continued discourses into which these words enter sufficiently, when we form true notions of the actions, particularly the visible ones attending them.

Eleventhly, The names of intellectual and moral qualities and operations, such as fancy, memory, wit, dulness, virtue, vice, conscience, approbation, disapprobation, &c. stand for a description of these qualities and operations; and therefore, if dwelt upon, excite such ideas as these descriptions in all their particular circumstances do. But the common sentences, which these words enter, pass over the mind too quick, for the most part, to allow of such a delay. They are acknowledged as familiar and true, and suggest certain associated visible ideas, and nascent internal feelings, taken from the descriptions of these names, or from the words, which are usually joined with them in discourses or writings.

Twelfthly, There are many terms of art in all the branches of learning, which are defined by other words, and which therefore are only compendious substitutes for them. The same holds in common life in numberless instances. Thus riches, honours, pleasures, are put for the several kinds of each. Such words sometimes suggest the words of their definitions, sometimes the ideas of these words, sometimes a particular species comprehended under the general term, &c. But, whatever they suggest, it may be easily seen, that they derive the power of doing this from association.

Thirteenthly, There are many words used in abstract sciences, which can scarce be defined or described by any other words; and yet, by their grammatical form, seem to be excluded from the class of particles.

particles. Such are identity, existence, &c. The use of these must therefore be learnt as that of the particles is. And indeed children learn their first imperfect notions of all the words considered in this and the three last paragraphs chiefly in this way; and come to precise and explicit ones only by means of books, as they advance to adult age, or by endeavouring to use them properly in their own deliberate compositions.

This is by no means a full or satisfactory account of the ideas which adhere to words by association. For the author perceives himself to be still a mere novice in these speculations; and it is difficult to explain words to the bottom by words; perhaps impossible. The reader will receive some addition of light and evidence in the course of this section; also in the next, in which I shall treat of propositions and assent. For our assent to propositions, and the influence which they have over our affections and actions, make part of the ideas that adhere to words by association; which part, however, could not properly be considered in this section.

COR. 1. It follows from this proposition, that words may be distinguished into the four classes mentioned under the twelfth proposition.

1. Such as have ideas only.
2. Such as have both ideas and definitions.
3. Such as have definitions only.
4. Such as have neither ideas nor definitions.

Under definition I here include description, or any other way of explaining a word by other words, excepting that by a mere synonymous term; and I exclude from the number of ideas the visible idea of the character of a word, and the audible one of its sound; it being evident, that every word heard may thus excite a visible idea, and every word seen an audible one. I exclude also all ideas that are either extremely faint, or extremely variable.

It is difficult to fix precise limits to these four classes, so as to determine accurately where each ends, and the next begins; and, if we consider these things in the most general way, there is perhaps no word which has not both an idea and a definition, *i. e.* which is not attended by some one or more internal feelings occasionally, and which may not be explained, in some imperfect manner at least, by other words. I will give some instances of words which have the fairest right to each class.

The names of simple sensible qualities are of the first class. Thus *white, sweet, &c.* excite ideas; but cannot be defined. It is to be observed here, that this class of words stands only for the stable part of the ideas respectively, not for the several variable particularities, circumstances, and adjuncts, which intermix themselves here.

The names of natural bodies, animal, vegetable, mineral, are of the second class; for they excite aggregates of sensible ideas, and at the same time may be defined (as appears from the writings of natural historians) by an enumeration of their properties and characteristics. Thus likewise geometrical figures have both ideas and definitions. The definitions in both cases are so contrived as to leave out all the variable particularities of the ideas, and to be also more full and precise, than the ideas generally are in the parts that are of a permanent nature.

Algebraic quantities, such as roots, powers, surds, &c. belong to the third class, and have definitions only. The same may be said of scientific terms of art, and of most abstract general terms, moral, metaphysical, vulgar: however, mental emotions are apt to attend some of these even in passing slightly over the ear; and these emotions may be considered as ideas belonging to the terms respectively. Thus the very words, *gratitude, mercy, cruelty, treachery, &c.* separately taken, affect the mind; and

yet

yet, since all reasoning upon them is to be founded on their definitions, as will be seen hereafter, it seems best to refer them to this third class.

Lastly, the particles *the, of, to, for, but, &c.* have neither definitions nor ideas.

COR. 2. This matter may be illustrated by comparing language to geometry and algebra, the two general methods of expounding quantity, and investigating all its varieties from previous *data*.

Words of the first class answer to propositions purely geometrical, *i. e.* to such as are too simple to admit of algebra; of which kind we may reckon that concerning the equality of the angles at the basis of an Isosceles triangle.

Words of the second class answer to that part of geometry, which may be demonstrated either synthetically or analytically; either so that the learner's imagination shall go along with every step of the process painting out each line, angle, &c. according to the method of demonstration used by the ancient mathematicians; or so that he shall operate entirely by algebraic quantities and methods, and only represent the conclusion to his imagination, when he is arrived at it, by examining then what geometrical quantities the ultimately resulting algebraical ones denote. The first method is in both cases the most satisfactory and affecting, the last the most expeditious, and not less certain, where due care is taken. A blind mathematician must use words in the last of these methods, when he reasons upon colours.

Words of the third class answer to such problems concerning quadratures, and rectifications of curves, chances, equations of the higher orders, &c. as are too perplexed to be treated geometrically.

Lastly, Words of the fourth class answer to the algebraic signs for addition, subtraction, &c. to indexes, coefficients, &c. These are not algebraic quantities themselves; but they alter the import of

the letters that are; just as particles vary the sense of the principal words of a sentence, and yet signify nothing of themselves.

Geometrical figures may be considered as representing all the modes of extension in the same manner, as visible ideas do visible objects; and consequently the names of geometrical figures answer to the names of these ideas. Now as all kinds of problems relating to quantity might be expounded by modes of extension, and solved thereby, were our faculties sufficiently exalted, so it appears possible to represent most kinds of ideas by visible ones, and to pursue them in this way through all their varieties and combinations. But as it seems best in the first case to confine geometry to problems, where extension, and motion, which implies extension, are concerned, using algebraic methods for investigating all other kinds of quantity, so it seems best also to use visible ideas only for visible objects and qualities, of which they are the natural representatives, and to denote all other qualities by words considered as arbitrary signs. And yet the representation of other quantities by geometrical ones, and of other ideas by visible ones, is apt to make a more vivid impression upon the fancy, and a more lasting one upon the memory. In similes, fables, parables, allegories, visible ideas are used for this reason to denote general and intellectual ones.

Since words may be compared to the letters used in algebra, language itself may be termed one species of algebra; and, conversely, algebra is nothing more than the language which is peculiarly fitted to explain quantity of all kinds. As the letters, which in algebra stand immediately for quantities, answer to the words which are immediate representatives of ideas, and the algebraic signs for addition, &c. to the particles; so the single letters, which are sometimes used by algebraists to denote sums or differences,

ences, powers or roots universal of other letters, for brevity and convenience, answer to such words as have long definitions, to terms of art, &c. which are introduced into the sciences for the sake of compendiousness. Now, if every thing relating to language had something analogous to it in algebra, one might hope to explain the difficulties and perplexities attending the theory of language by the corresponding particulars in algebra, where every thing is clear, and acknowledged by all that have made it their study. However, we have here no independent point whereon to stand, since, if a person be disposed to call the rules of algebra in question, we have no way of demonstrating them to him, but by using words, the things to be explained by algebra, for that purpose. If we suppose indeed the sceptical person to allow only that simple language, which is necessary for demonstrating the rules of algebra, the thing would be done; and, as I observed just now, it seems impossible to become acquainted with this, and at the same time to disallow it.

COR. 3. It will easily appear from the observations here made upon words, and the associations which adhere to them, that the languages of different ages and nations must bear a great general resemblance to each other, and yet have considerable particular differences; whence any one may be translated into any other, so as to convey the same ideas in general, and yet not with perfect precision and exactness. They must resemble one another, because the phenomena of nature, which they are all intended to express, and the uses and exigencies of human life, to which they minister, have a general resemblance. But then, as the bodily make and genius of each people, the air, soil, and climate, commerce, arts, sciences, religion, &c. make considerable differences in different ages and nations, it is natural to expect,

pect, that the languages should have proportionable differences in respect of each other.

Where languages have rules of etymology and syntax, that differ greatly, which is the case of the *Hebrew* compared with *Greek* or *Latin*, this will become a new source of diffimity. For the rules of etymology and syntax determine the application and purport of words in many cases. Agreeably to which we see, that children, while yet unacquainted with that propriety of words and phrases, which custom establishes, often make new words and constructions, which, though improper according to common usage, are yet very analogous to the tenor of the language, in which they speak.

The modern languages of this western part of the world answer better to the *Latin*, than according to their original *Gothic* plans, on this account; inasmuch as not only great numbers of words are adopted by all of them from the *Latin*, but also because the reading *Latin* authors, and learning the *Latin* grammar, have disposed learned men and writers to mould their own languages in some measure after the *Latin*. And, conversely, each nation moulds the *Latin* after the idiom of its own language, the effect being reciprocal in all such cases.

In learning a new language the words of it are at first substitutes for those of our native language, *i. e.* they are associated, by means of these, with the proper objects and ideas. When this association is sufficiently strong, the middle bond is dropped, and the words of the new language become substitutes for, and suggest directly and immediately objects and ideas; also clusters of other words in the same language.

In learning a new language it is much easier to translate from it into the native one, than back again; just as young children are much better able to understand the expressions of others, than to express their own conceptions. And the reason is the same in

both

both cases. Young children learn at first to go from the words of others; and those who learn a new language, from the words of that language, to the things signified. And the reverse of this, viz. to go from the things signified to the words, must be difficult for a time, from what is delivered concerning successive associations under the tenth and eleventh propositions. It is to be added here, that the nature and connections of the things signified often determine the import of sentences, though their grammatical analysis is not understood; and that we suppose the person who attempts to translate from a new language is sufficiently expert in the inverse problem of passing from the things signified to the corresponding words of his own language. The power of association is every where conspicuous in these remarks.

COR. 4. It follows also from the reasoning of this proposition, that persons who speak the same language cannot always mean the same things by the same words; but must mistake each other's meaning. This confusion and uncertainty arises from the different associations transferred upon the same words by the difference in the accidents and events of our lives. It is, however, much more common in discourses concerning abstract matters, where the terms stand for collections of other terms, sometimes at the pleasure of the speaker or writer, than in the common and necessary affairs of life. For here frequent use, and the constancy of the phenomena of nature, intended to be expressed by words, have rendered their sense determinate and certain. However, it seems possible, and even not very difficult, for two truly candid and intelligent persons to understand each other upon any subject.

That we may enter more particularly into the causes of this confusion, and consequently be the better

better enabled to prevent it, let us consider words according to the four classes above-mentioned.

Now mistakes will happen in the words of the first class, viz. such as have ideas only, where the persons have associated these words with different impressions. And the method to rectify any mistake of this kind is for each person to shew with what actual impressions he has associated the word in question. But mistakes here are not common.

In words of the second class, viz. such as have both ideas and definitions, it often happens, that one person's knowledge is much more full than another's, and consequently his idea and definition much more extensive. This must cause a misapprehension on one side, which yet may be easily rectified by recurring to the definition. It happens also sometimes in words of this class, that a man's ideas, *i. e.* the miniatures excited in his nervous system by the word, are not always suitable to his definition, *i. e.* are not the same with those which the words of the definition would excite. If then this person should pretend, or even design, to reason from his definition, and yet reason from his idea, a misapprehension will arise in the hearer, who supposes him to reason from his definition merely.

In words of the third class, which have definitions only, and no immediate ideas, mistakes generally arise through want of fixed definitions mutually acknowledged, and kept to. However, as imperfect fluctuating ideas, that have little relation to the definitions, are often apt to adhere to the words of this class, mistakes must arise from this cause also.

As to the words of the fourth class, or those which have neither ideas nor definitions, it is easy to ascertain their use by inserting them in sentences, whose import is known and acknowledged; this being the method in which children learn to decypher them: so that mistakes could not arise in the words of this class,

class, did we use moderate care and candour. And indeed since children learn the uses of words most evidently without having any *data*, any fixed point at all, it is to be hoped, that philosophers, and candid persons, may learn at last to understand one another with facility and certainty; and get to the very bottom of the connection between words and ideas.

It seems practicable to make a dictionary of any language, in which the words of that language shall all be explained with precision by words of the same language, to persons who have no more than a gross knowledge of that language. Now this also shews, that with care and candour we might come to understand one another perfectly. Thus sensible qualities might be fixed by the bodies, in which they are most eminent and distinct; the names of a sufficient number of these bodies being very well known. After this these very bodies, and all others, might be defined by their sensible properties; and these two processes would help each other indefinitely. Actions might be described from animals already defined, also from the modes of extension, abstract terms defined, and the peculiar use of particles ascertained. And such a dictionary would, in some measure, be as real as well as a nominal one, and extend to things themselves. The writer of every new and difficult work may execute that part of such a dictionary which belongs to his subject; at least in the instances where he apprehends the reader is likely to want it.

Cor. 5. When words have acquired any considerable power of exciting pleasant or painful vibrations in the nervous system, by being often associated with such things as do this, they may transfer a part of these pleasures and pains upon indifferent things, by being at other times often associated with such. This is one of the principal sources of the several various pleasures and pains of human life. Thus, to give

give an instance from childhood, the words *sweet*, *good*, *pretty*, *fine*, &c. on the one hand, and the words, *bad*, *ugly*, *frightful*, &c. on the other, being applied by the nurse and attendants in the young child's hearing almost promiscuously, and without those restrictions that are observed in correct speaking, the one to all the pleasures, the other to all the pains of the several senses, must by association raise up general pleasant and painful vibrations, in which no one part can be distinguished above the rest; and, when applied by farther associations to objects of a neutral kind, they must transfer a general pleasure or pain upon them.

All the words associated with pleasures must also affect each other by this promiscuous application. And the same holds in respect of the words associated with pains. However, since both the original and the transferred pleasures and pains heaped upon different words are different, and in some cases widely so, every remarkable word will have a peculiar internal feeling, or sentiment, belonging to it; and there will be the same relations of affinity, disparity, and opposition, between these internal sentiments, *i. e.* ideas, belonging to words, as between the several *genera* and *species* of natural bodies, between tastes, smells, colours, &c. Many of these ideas, though affording considerable pleasure at first, must sink into the limits of indifference; and some of those which afforded pain at first, into the limits of pleasure. What is here said of words, belongs to clusters of them, as well as to separate words. And the ideas of all may still retain their peculiarities, by which they are distinguished from each other, after they have fallen below the limits of pleasure into indifference, just as obscure colours, or faint tastes, do.

It is observable, that the mere transit of words expressing strong ideas over the ears of children affects them; and the same thing is true of adults, in
a less

a less degree. However the last have learnt from experience and habit to regard them chiefly, as they afford a rational expectation of pleasure and pain. This cannot be discussed fully, till we come to consider the nature of assent; but it may give some light and evidence to the reasoning of this corollary, just to have mentioned the manner, in which we are at first affected by words.

COR. 6. Since words thus collect ideas from various quarters, unite them together and transfer them both upon other words, and upon foreign objects, it is evident, that the use of words adds much to the number and complexness of our ideas, and is the principal means by which we make intellectual and moral improvements. This is verified abundantly by the observations that are made upon persons born deaf, and continuing so. It is probable, however, that these persons make use of some symbols to assist the memory, and fix the fancy: and they must have a great variety of pleasures and pains transferred upon visible objects from their associations with one another, and with sensible pleasures of all the kinds; but they are very deficient in this, upon the whole, through the want of the associations of visible objects, and states of mind, &c. with words. Learning to read must add greatly to their mental improvement; yet still their intellectual capacities cannot but remain very narrow.

Persons blind from birth must proceed in a manner different from that described in this proposition, in the first ideas, which they affix to words. As the visible ones are wanting, the others, particularly the tangible and audible ones, must compose the aggregates which are annexed to words. However, as they are capable of learning and retaining as great a variety of words as others, or perhaps a greater, *ceteris paribus*, and can associate with them pleasures and pains from the four remaining senses, also use them

them as algebraists do the letters that represent quantities, they fall little or nothing short of others in intellectual accomplishments, and may arrive even at a greater degree of spirituality, and abstraction in their complex ideas.

COR. 7. It follows from this proposition, that, when children or others first learn to read, the view of the words excites ideas only by the mediation of their sounds, with which alone their ideas have hitherto been associated. And thus it is that children and illiterate persons understand what they read best by reading aloud. By degrees, the intermediate link being left out, the written or printed characters suggest the ideas directly and instantaneously; so that learned men understand more readily by passing over the words with the eye only, since this method, by being more expeditious, brings the ideas closer together. However, all men, both learned and unlearned, are peculiarly affected by words pronounced in a manner suitable to their sense and design; which is still an associated influence.

COR. 8. As persons, before they learn to read, must have very imperfect notions of the distinction of words, and can only understand language in a gross general way, taking whole clusters of words for one undivided sound, so much less can they be supposed to have any conceptions concerning the nature or use of letters. Now all mankind must have been in this state before the invention of letters. Nay, they must have been farther removed from all conceptions of letters, than the most unlearned persons amongst us, since these have at least heard of letters, and know that words may be written and read by means of them. And this makes it difficult to trace out by what steps alphabetical writing was invented; or is even some presumption, that it is not a human invention. To which it is to be added, that the analysing complex articulate sounds into their simple component parts appears to be a problem of too difficult and perplexed

a nature

a nature for the rude early ages, occupied in getting necessities, and defending themselves from external injuries, and not aware of the great use of it, even though they had known the solution to be possible and practicable. However, I shall mention some presumptions of a contrary nature under the next proposition.

P R O P. LXXXI.

To explain the Nature of Characters intended to represent Objects and Ideas immediately, and without the Intervention of Words.

SINCE characters made by the hand are capable of the greatest varieties, they might be fitted by proper associations to suggest objects and ideas immediately, in the same manner as articulate sounds do. And there are some instances of it in common use, which may serve to verify this, and to lead us into the nature of characters standing immediately for objects and ideas. Thus the numeral figures, and the letters in algebra, represent objects, ideas, words, and clusters of words, directly and immediately; the pronunciation of them being of no use, or necessity, in the operations to be performed by them. Thus also musical characters represent sounds and combinations of sounds, without the intervention of words, and are a much more compendious and ready representation, than any words can be.

Characters seem to have an advantage over articulate sounds in the representation of visible objects, inasmuch as they might by their resemblance, even though only a gross one, become rather natural, than mere arbitrary representatives.

They had also an advantage as representatives in general, before the invention of alphabetical writing, since persons could by this means convey their thoughts to each other at a distance.

If we suppose characters to be improved to all that variety and multiplicity, which is necessary for representing objects, ideas, and clusters of characters, in the same manner as words represent objects, ideas, and clusters of words, still they might be resolved into simple component parts; and rendered pronounciable by affixing some simple or short sound to each of these simple component parts; just as articulate sounds are painted by being first resolved into their simple component parts, and then having each of these represented by a simple mark or character.

If we suppose the most common visible objects to be denoted both by short articulate sounds, and by short characters bearing some real, or fancied, imperfect resemblance to them, it is evident, that the sound and mark, by being both associated with the visible object, would also be associated with one another; and consequently that the sound would be the name of the mark, and the mark the picture of the sound. And this last circumstance seems to lead to the denoting all sounds by marks, and therefore perhaps to alphabetical writing.

At the same time it must be observed, that the marks would bear different relations of similarity and dissimilarity to one another from those which the corresponding sounds did.

This would happen according to whatever law the marks were made, but especially if they were resemblances of visible objects. And this, as it seems, would occasion some difficulty and perplexity in representing sounds by marks, or marks by sounds.

P R O P. LXXXII.

To explain the Nature of figurative Words and Phrases,
and of Analogy, from the foregoing Theory.

A FIGURE is a word, which, first representing the object or idea *A*, is afterwards made to represent *B*, on account of the relation, which these bear to each other.

The principal relation, which gives rise to figures, is that of likeness; and this may be either a likeness in shape, and visible appearance, or one in application, use, &c. Now it is very evident from the nature of association, that objects which are like to a given one in visible appearance, will draw to themselves the word by which this is expressed. And indeed this is the foundation upon which appellatives are made to stand for so great a number of particulars. Let the word *man* be applied to the particular persons *A*, *B*, *C*, &c. till it be sufficiently associated with them, and it will follow, that the appearance of the new particular person *D* will suggest the word, and be denoted by it. But here there is no figure, because the word *man* is associated with different particular persons from the first, and that equally or nearly so.

In like manner, the corresponding parts of different animals, *i. e.* the eyes, mouth, breast, belly, legs, lungs, heart, &c. have the same names applied in a literal sense, partly from the likeness of shape, partly from that of use and application. And it is evident, that if we suppose a people so rude in language and knowledge, as to have names only for the parts of the human body, and not to have extended to the parts of the brute creatures, association would lead them to apply the same names to the parts of the brute creatures, as soon as they be-

came acquainted with them. Now here this application would at first have the nature of a figure; but when by degrees any of these words, the eye for instance, became equally applied from the first to the eyes of men and brutes, it would cease to be a figure, and become an appellative name, as just now remarked.

But when the original application of the word is obvious, and remains distinct from the secondary one, as when we say the mouth or ear of a vessel, or the foot of a chair or table, the expression is figurative.

Hence it is plain, that the various resemblances which nature and art afford are the principal sources of figures. However, many figures are also derived from other relations, such as those of cause, effect, opposition, derivation, generality, particularity; and language itself, by its resemblances, oppositions &c. becomes a new source of figures, distinct from the relations of things.

Most metaphors, *i. e.* figures taken from likeness, imply a likeness in more particulars than one else they would not be sufficiently definite, nor affect the imagination in a due manner. If the likeness extend to many particulars, the figure becomes implicitly a simile, fable, parable, or allegory.

Many, or most common figures, pass so far into literal expressions by use, *i. e.* association, that we do not attend at all to their figurative nature. And thus by degrees figurative senses become a foundation for successive figures, in the same manner, originally literal senses.

It is evident, that if a language be narrow, and much confined to sensible things, it will have great occasion for figures: these will naturally occur in the common intercourses of life, and will in their turn as they become literal expressions in the secondary senses, much augment and improve the language.

and assist the invention. All this is manifest from the growth of modern languages, in those parts where they were heretofore particularly defective.

We come now to the consideration of analogy. Now things are said to be analogous to one another, in the strict mathematical sense of the word *analogy*, when the corresponding parts are all in the same ratio to each other. Thus if the several parts of the body in different persons be supposed exactly proportional to the whole bodies, they might be said to be analogous in the original mathematical sense of that word. But as this restrained sense is not applicable to things, as they really exist, another of a more enlarged and practical nature has been adopted, which may be thus defined. Analogy is that resemblance, and in some cases sameness, of the parts, properties, functions, uses, &c. any or all, of *A* to *B*, whereby our knowledge concerning *A*, and the language expressing this knowledge, may be applied in the whole, or in part, to *B*, without any sensible, or, at least, any important practical error. Now analogies, in this sense of the word, some more exact and extensive, some less so, present themselves to us every where in natural and artificial things; and thus whole groups of figurative phrases, which seem at first only to answer the purposes of convenience in affording names for new objects, and of pleasing the fancy in the way to be hereafter mentioned, pass into analogical reasoning, and become a guide in the search after truth, and an evidence for it in some degree. I will here set down some instances of analogies of various degrees and kinds.

The bodies of men, women, and children, are highly analogous to each other. This holds equally in respect of every other species of animals; also of the several corresponding parts of animals of the same species, as their flesh, blood, bones, fat, &c. and their properties. Here the words applied to

the several analogous things are used in a sense equally literal in respect of all. And the analogy is in most cases so close, as rather to be esteemed a coincidence, or sameness.

In comparing animals of different kinds the analogy grows perpetually less and less, as we take in a greater compass; and consequently our language more and more harsh, when considered as literal, whilst yet it cannot well be figurative in some things, and literal in others; so that new words are generally assigned to those parts, which do not sufficiently resemble the corresponding ones. Thus the fore-legs of men and fowls, as we might call them in a harsh, literal, or a highly figurative way, are termed hands and wings respectively. However, in some cases, the same word is used, and considered as a figure; as when the cries of birds and beasts are termed their language. We may also observe, that every part in every animal may, from its resemblance in shape and use to the corresponding parts in several other animals have a just right to a name, which shall be common to it and them.

What has been said of animals of the same and different kinds holds equally in respect of vegetables. Those of the same kind have the same names applied to the corresponding parts in a literal sense. Those of different kinds have many names common to all used in a literal sense, some new ones peculiar to certain kinds, and some that may be considered as so harsh in a literal sense, that we may rather call them figurative terms.

The same may be said of the mineral kingdom considered also according to its *genera* and *species*.

Animals are also analogous to vegetables in many things, and vegetables to minerals: so that there seems to be a perpetual thread of analogy continued from the most perfect animal to the most imperfect mineral, even till we come to elementary bodies themselves.

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Suppose the several particulars of the three kingdoms to be represented by the letters of an alphabet sufficiently large for that purpose. Then we are to conceive, that any two contiguous species, as *A* and *B*, *M* and *N*, are more analogous than *A* and *C* and *M* and *O*, which have one between them. However, since *A* and *B*, *M* and *N*, are not perfectly analogous, this deficiency may be supplied in some things from *C* and *O*, in others from *D* and *P*, &c. so that *M* can have no part, property, &c. but what shall have something quite analogous to it in some species, near or remote, above it or below it, and even in several species. And in cases where the parts, properties, &c. are not rigorously exact in resemblance, there is, however, an imperfect one, which justifies the application of the same word to both; if it approach to perfection, the word may be said to be used in a literal sense; if it be very imperfect, in a figurative one. Thus when the names of parts, properties, &c. are taken from the animal kingdom, and applied to the vegetable, or *vice versa*, they are more frequently considered as figurative, than when transferred from one part of the animal kingdom to another.

In like manner, there seems to be a gradation of analogies respecting the earth, moon, planets, comets, sun, and fixed stars, compared with one another. Or if we descend to the several parts of individuals, animals, vegetables, or minerals, the several organs of sensation are evidently analogous to each other; also the glands, the muscles, the parts of generation in the different sexes of the same kind, &c. &c. without limits. For the more any one looks into the external natural world, the more analogies, general or particular, perfect or imperfect, will he find every where.

Numbers, geometrical figures, and algebraic quantities, are also mutually analogous without limits.

And here there is the exactest uniformity, joined with an endless variety, so that it is always certain and evident how far the analogy holds, and where it becomes a disparity or opposition on one hand, or a coincidence on the other. There is no room for figures here; but the terms must be disparate, opposite, or the same, in a strictly literal sense respectively.

The several words of each particular language, the languages themselves, the idioms, figures, &c. abound also with numerous analogies of various kinds and degrees.

Analogies are likewise introduced into artificial things, houses, gardens, furniture, dress, arts, &c.

The body politic, the body natural, the world natural, the universe;—The human mind, the minds of brutes on one hand, and of superior beings on the other, and even the infinite mind himself;—the appellations of father, governor, judge, king, architect, &c. referred to God;—the ages of man, the ages of the world, the seasons of the year, the times of the day;—the offices, professions, and trades, of different persons, statesmen, generals, divines, lawyers, physicians, merchants;—the terms night, sleep, death, chaos, darkness, &c. also light, life, happiness, &c. compared with each other respectively; life and death, as applied in different senses to animals, vegetables, liquors, &c.—earthquakes, storms, battles, tumults, fermentations of liquors, law-suits, games, &c. families, bodies politic lesser and greater, their laws, natural religion, revealed religion, &c. &c. afford endless instances of analogies natural and artificial. For the mind being once initiated into the method of discovering analogies, and expressing them, does by association persevere in this method, and even forces things into its system by concealing disparities, magnifying resemblances, and accommodating language thereto.

thereto. It is easy to see, that in the instances last alleged the terms used are for the most part literal only in one sense, and figurative in all their other applications. They are literal in the sense which was their primary one, and figurative in many or most of the rest. Similes, fables, parables, allegories, &c. are all instances of natural analogies improved and set off by art. And they have this in common to them all, that the properties, beauties, perfections, desires, or defects and aversions, which adhere by association to the simile, parable or emblem of any kind, are insensibly, as it were, transferred upon the thing represented. Hence the passions are moved to good or to evil, speculation is turned into practice, and either some important truth felt and realized, or some error and vice gilded over and recommended.

P R O P. LXXXIII.

To apply the foregoing Account of Words and Characters to the Languages and Method of Writing of the first Ages of the World.

HERE there is a great difficulty through the want of sufficient *data*. I will assume a few of those that appear to me most probable, and just shew the method of applying the doctrine of association to them; leaving it to learned men, as they become possessed of more and more certain *data*, to make farther advances.

I suppose then, that *Adam* had some language, with some instinctive knowledge concerning the use of it, as well as concerning divine and natural things, imparted to him by God at his creation. It seems indeed, that God made use of the visible appearances or actions, or perhaps of the several cries of the brute creatures, as the means whereby he taught *Adam* their names. But whether this was so, also whether,

whether, if it was, any analogous method was taken in respect of the names of other objects, or of ideas, and internal feelings, is an inquiry, in which nothing that yet appears can afford satisfaction.

I suppose also, that the language, which *Adam* and *Eve* were possessed of in paradise was very narrow, and confined in great measure to visible things; God himself condescending to appear in a visible, perhaps in a human shape, to them, in his revelations of himself. It might also be monosyllabic in great measure. They who suppose *Adam* to be capable of deep speculations, and to have exceeded all his posterity in the subtilty and extent of his intellectual faculties, and consequently in the number and variety of his words, and the ideas belonging to them, have no foundation for this opinion in scripture; nor do they seem to consider, that innocence, and pure unmixed happiness, may exist without any great degrees of knowledge; or that to set a value upon knowledge considered in itself, and exclusively of its tendency to carry us to God, is a most pernicious error, derived originally from *Adam's* having eaten of the tree of knowledge.

After the fall we may suppose, that *Adam* and *Eve* extended their language to new objects and ideas, and especially to those which were attended with pain; and this they might do sometimes by inventing new words, sometimes by giving new senses to old ones. However, their language would still continue narrow, because they had only one another to converse with, and could not extend their knowledge to any great variety of things; also because their foundation was narrow. For the growth and variations of a language somewhat resemble the increase of money at interest upon interest.

If to these reasons we add the long lives of the antediluvian patriarchs, the want of arts and sciences in the antediluvian world, and the want of leisure through

through the great labour and fatigue necessary to provide food, clothing, &c. we shall have reason to conjecture, that the whole antediluvian world would speak the same language with *Adam*, and that without any great additions or alterations. After a hundred or two hundred years, association would fix the language of each person, so that he could not well make many alterations; but he must speak the language of his forefathers till that time, because those to the sixth or seventh generation above him were still living; and consequently he would continue to speak the same language, *i. e.* the *Adamic*, with few variations, to the last. The narrowness of the languages of barbarous nations may add some light and evidence here.

If we suppose some kind of picture-writing to have been imparted to *Adam* by God, or to have been invented by him, or by any of his posterity, this might receive more alterations and improvements than language, from the successive generations of the antediluvians. For the variety of figures in visible objects would suggest a sufficient variety in their characters; the hand could easily execute this; and their permanency would both give the antediluvians distinct ideas of all the original characters, and all their variations, and also fix them in their memory. We may suppose therefore, that though their words and marks would be so associated together (agreeably to what was before observed), as that the word would be the name of the corresponding mark, and the mark the picture of the word in many cases, yet their marks would in some instances extend farther than their words; and consequently, that on this account, as well as because the marks would be similar and different, where the words were not, there would be no alphabetical writing in the antediluvian world.

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They might, however, hand down a history of the creation, fall, and principal events, in this picture-writing, attended with a traditional explanation, which might remain uncorrupted and invariable till the deluge. And indeed, if we suppose picture-writing to be of divine original, it will be most probable, that they received a divine direction to do this, and that they would not apply their picture-writing to any other purpose for some time: just as the *Israelites* afterwards seem to have employed alphabetical writing chiefly for recording the divine dispensations and interpositions.

After the flood the great change made in the face of things, and in natural bodies, with the appearance perhaps of some entirely new ones, would make some parts of the antediluvian language superfluous, at the same time that it would be greatly defective upon the whole. Hence we may suppose, that the antediluvian language must receive much greater alterations and additions just after the flood, than at any time before. But *Noah* and his wife, having their words and ideas more firmly associated together, than *Shem*, *Ham*, and *Japhet*, and their wives, on account of their superior age, would be far less able to make the requisite changes in their language. Something like this must also take place in respect of their picture-writing, if we suppose there was any such thing in the antediluvian world.

Let us suppose this, and also with Mr. *Whiston* and Mr. *Shuckford*, that *Noah*, his wife, and their postdiluvian posterity, settled early in *China*, so as to be cut off from *Shem*, *Ham*, and *Japhet*, and their posterity. Here then we may suppose farther, that they would alter and improve their picture-writing, or character, so as to suit it to the new face of things in the postdiluvian world, and to make it grow with the growth of knowledge, more than they would their language, from the greater facility of

doing

doing this : for I presume, that the antediluvian language contained but few of the articulate sounds which are now known, and that they could not invent more. Thus their character and language would both of them be the immediate representatives of objects and ideas ; only the use and application of the character would be much more extensive than that of the language. After some time, some centuries, or even chiliads, suppose, both the character and language would begin to be fixed, to have fewer new marks and words added, and fewer alterations made in the old ones in any given interval of time. The words would also be so firmly associated with the corresponding marks, as to be the names of them, *i. e.* to represent them as well as the objects or ideas, to which they were originally affixed. But then there would be many marks, to which there would be no such names, taken from the names of objects and ideas, on account of the poverty of the language here supposed. They would, however, endeavour to give them some names ; and hence a diversity would arise in their language. We may conceive also, that as they separated farther from one another in multiplying, particular clans would deviate even in the pronunciation of the monosyllabic words of the original language, as in the several dialects of other languages ; and consequently deviate still more in the compound names of the marks : but the marks, being permanent things, capable of being handed down accurately to the successive generations, and of being conveyed to distant countries, would continue intelligible to all. And thus we may conceive, that the postdiluvian posterity of *Noah* might all write the same characters, and yet speak different languages ; also that their character would be very extensive, and always the immediate representative of objects and ideas, whereas their language would be narrow, and in some cases the immediate representative of the character,

character, and only denote objects and ideas by means of this. And this I take to be the case with the people of *China*, and the neighbouring countries of *Japan*, *Tonquin*, *Siam*, &c. But I only presume to offer conjectures, not having any knowledge of the character or languages of these countries.

Since the *Chinese* marks are very numerous, and their simple words very few, whereas our words are very numerous, and our simple marks, or the letters of our alphabet, very few; also since our words are the sole immediate representatives of objects and ideas, our written and printed marks being merely artificial pictures of words; one might suspect, that the *Chinese* words are, in correspondence to this, merely an artificial enunciation of their character. But I think this not so probable, as the mixed supposition mentioned in the last paragraph. For it cannot be supposed, that any nation should be so far destitute of language, as not to have words for common objects, and internal feelings; or, having these, that they should lay them entirely aside, and adopt the artificial names of the marks representing those objects and ideas in their steads. But they might easily adopt names, simple or compound, at first ascribed artificially to marks, whose objects and ideas had before this adoption no names.

That in affixing names artificially to marks a great diversity might arise, appears from the great diversity of alphabetical characters expressing the same words. Thus the *Hebrew*, *Samaritan* and *Syriac* languages, agree nearly in sound and sense, but differ entirely in characters. Thus also, amongst modern languages, several are written in different characters, as *English* in the common round-hand in various law hands, and various short hands.

Let us now return to *Shem*, *Ham*, and *Japhet*, and their posterity. They must be supposed to proceed in the same manner, in general, as *Noah*, and his im-
mediate

mediate posterity, till the confusion of tongues at *Babel*; excepting that *Shem*, *Ham*, and *Japhet*, with their wives, would be more apt to alter their character and language, and suit them to their present exigencies, than *Noah* and his wife, on account of their being all young persons; also that, being all as it were equal to each other they might each of them be the authors of certain diversities in the common character and language, and establish them in their respective posterities. However, if *Noah* be supposed to have continued with them till the division of the earth by God's command, and then only to have departed with his postdiluvian posterity for *China*, the country assigned to him, whilst *Shem*, *Ham*, and *Japhet*, with their posterity, began to build the tower of *Babel* in opposition to God's command, then *Noah*, and all his sons, &c. must be supposed to have suited their character and language to the new world in nearly the same manner.

The confusion of tongues at *Babel* appears to me to be miraculous for the following reasons.

First, This appears to be the most natural interpretation of the text.

Secondly, Thus the confusion of tongues will correspond to the gift of language imparted to *Adam* at his creation, which must be supposed; also to the gift of tongues at *Pentecost*.

Thirdly, Learned men seem to have shewn, that the diversity of ancient languages does by no means favour the supposition of a natural derivation of them all from one original form.

Fourthly, The original plan of the *Greek* and *Latin* tongues (which I consider as sister languages derived from the same mother or original plan), appears to have been very uniform, yet with a considerable variety. Now I think this uniformity and variety could scarce be invented and established by rude multitudes, almost entirely occupied in providing necessities

necessaries for themselves, and much less as alphabetical writing seems to be of later date than the diversity of languages. And in fact we do not find, that barbarous nations do by length of time improve their languages so as in any measure to approach to the perfection of the *Greek* or *Latin*, or of their common mother. It adds strength to this argument, that the original plan of the *Greek* and *Latin*, i. e. the rules of etymology and syntax, as grammarians call them, is entirely different from that of the *Hebrew* and *Arabic* (whose original plans agree), though the first colonies, which came by sea into *Greece* and *Italy*, came from *Palestine* and *Egypt*, i. e. from the neighbourhood of countries where *Hebrew* and *Arabic* were spoken.

Fifthly, The natural deviation of languages since history has been clear and certain, does by no means correspond to a supposed natural derivation of all languages from one mother-tongue, especially in so short a time as the interval between the flood and the rise of many different ancient languages. Let the reader here only reflect upon the great difference of the Biblical *Hebrew* from the ancientest *Greek* extant, and the small difference of this from modern *Greek*, or of the Biblical *Hebrew* from the Rabbinical.

If now the confusion of tongues was miraculous, we may conjecture from the agreements and disagreements of mother-languages from each other, that it was of the following kind.

First, That the original monosyllabic words of the antediluvian language were incorporated into each new language.

Secondly, That as these words included only few of the articulate sounds of which the human voice is capable, the several families were put upon making new articulations, some having one set, some another imparted to them.

Thirdly,

Thirdly, That each family had a new stock of words given them, consisting partly of old, partly of new articulations; and that this new stock far exceeded the old one in number and variety.

Fourthly, That a new and different etymology and syntax were also communicated to each family.

Fifthly, That there were as many new languages given as there are heads of families mentioned *Gen. x*; the confusion of tongues, by which the division of the earth was effected, not happening till *Joktan's* sons were old enough to be heads of families, though it had been determined and declared by God before. Those families, however, which were derived from the same stock, or had contiguous countries assigned to them, might be inspired with languages, that had a proportionable affinity.

Whatever may become of these particular conjectures, I think it highly probable, that the new languages far exceeded the old common one in the number and variety of words; and that the confusion of tongues was by this means a beneficial gift and blessing to mankind, as all God's other chastisements are to be.

We may also see reasons to make us judge, that a diversity of languages is suited to the other circumstances of mankind. For this must prevent the infection of vice from spreading with such rapidity, as it would otherwise have done, had mankind lived together in one large body, and had a free communication with each other by means of the same language.

Diversity of languages does also both help the invention, and correct false judgments. For we think in words, as appears by the foregoing theory, and invent chiefly by means of their analogies; at the same time that a servile adherence to those of any one language, or the putting words for things, would lead us into many errors. Now diversity of

languages does both enlarge the field of invention, and by opposing analogy to analogy preserve us from the prejudices derived from mere verbal agreements. Let me add here, that the abstract terms of logicians, metaphysicians, and school-men, which may be considered as a distinct language, have spiritualized men's understandings, and taught them to use words in reasoning, as algebraists do symbols.

Different languages do likewise improve one another, and help one another to grow in some proportion to the advancement in the knowledge of things.

Let us now examine the probable consequences of supposing different languages, and such as were far more copious than the old one, to be given at once miraculously.

First, then, The character, which suited the old language very imperfectly, would be still less suited to the new one.

Secondly, The new language might be more copious, and better adjusted to express objects and ideas, than the character. And this I think can scarce be doubted, if we suppose the new languages given miraculously.

Thirdly, The agreement between many of the marks of the character, and the words of the old language, may be supposed likely to put some persons upon denoting the words of the new language by marks. But whether this would necessarily lead to alphabetical writing, is very doubtful. I think not. The first attempts at least would not be alphabetical writing.

Fourthly, Persons of different families, who could not understand one another's language, might yet correspond by the character. However, one may guess from the circumstances of things in ancient times, that this would seldom take place in fact.

Fifthly

Fifthly, This and the convenience of corresponding with persons of the same family at a distance, also the desire of preserving memorials of remarkable events and transactions, might make them continue the use of the character, and improve it, considered as a method of conveying ideas, distinct from that of language. And the character thus separated from the language might give rise to hieroglyphical writing in all its varieties.

Sixthly, The patriarchs after the flood in the line of *Shem* might convey in succession the history of the creation, fall, deluge, calling of *Abraham*, &c. either in the original picture-writing improved, or in the mixed character, which according to the third of these consequences, denoted in some imperfect gross way the words of the new language. And some of the difficulties of the book of *Genesis* may be owing to its consisting of patriarchal records of one of these kinds, translated by *Moses* into the *Hebrew* of his own times, and then written alphabetically.

I do not think it *necessary* to have recourse to any such hypothesis as this, in order to vindicate the truth and authority of the book of *Genesis*. The length of life, even after the flood, to the time of *Moses*, appears sufficient for the preservation of such important traditional histories uncorrupted in the religious line of *Shem*, by natural means. Or God might interpose miraculously, as in so many other instances in patriarchal times.

If it be objected, that we have not the least intimation of writing of any kind in *Genesis*, I answer, that this is a difficulty. However, one cannot draw any certain conclusions from an omission. The original of writing is not likely to be one of the first things, which would be committed to writing. And if it was used only for the conveyance of important facts to the succeeding generations, we have no reason to expect the incidental mention of it. It

was probably so tedious and difficult a thing to express themselves accurately in it, and verbal messages and contracts so easy and natural in those simple ages, when the veracity of the messenger or contractor was not suspected, as that writing was never used after the confusion of tongues, when language became copious, unless in affairs of great consequence.

Picture-writing is alluded to in the second commandment, and must have been in use for some time before, since a system of idolatry had been founded upon it. And this may incline one to think, that it had been chiefly employed in sacred affairs, and therefore perhaps communicated originally to *Adam* by God. However, if we suppose, that it did not take place till after the flood, this will not totally vitiate the foregoing conjectures. The main purport of them may stand with due alterations and allowances. But it would be tedious to state all the varieties in things of so uncertain a nature.

I come now to the art of alphabetical writing. This I conjecture to have been communicated miraculously by God to *Moses* at *Sinai*, for the following reasons, which, however, I do not judge to be decisive ones.

First, then, God is said to have written with his own finger upon the tables of stone. And I think it would be harsh to suppose this done in conformity to, and, as one may say, imitation of, any mere imperfect human invention.

Secondly, The *Israelites* are the only people in the whole world that have preserved any regular account of their own original. This is easily accounted for upon supposition, that alphabetical writing was first given to them in perfection; and afterwards, supposed in the time of *Eli*, borrowed by other nations, and accommodated in an imperfect manner to their languages. But if we suppose any other nation, the *Egyptians* or *Arabians* for instance, to have invented

writing

writing before the time of *Moses*, it will be somewhat difficult to assign a reason, why other persons should not have borrowed this invention as well as *Moses*, and, like him, have given some account of their own nation, and their ancestors; and more difficult to assign a reason why the people, who invented alphabetical writing, should not do this.

As to the *Egyptians* in particular, their continuing to use hieroglyphical writing, and excelling in it, shews, that they could not have invented alphabetical; for this, if we suppose it invented so early as before the time of *Moses*, would have abolished that, just as the use of the ten cyphers has all the other imperfect methods of notation of numbers. Nor does it seem very likely, that hieroglyphical writing should lead to alphabetical, but rather from it, since hieroglyphical characters are the immediate representatives of objects and ideas, and the mediate representatives not of letters, or simple articulate sounds, but of words, and even of clusters of words. It seems probable also, that the *Egyptians* would even be backward in receiving alphabetical writing from the *Israelites* at the time that the *Philistines* or *Phœnicians* did; as being then greatly advanced in the use of their own hieroglyphical writing, and prejudiced in its favour. And thus we may solve that very difficult question, why the *Egyptians*, who seem to have erected a kingdom early (however, I judge *Nimrod's* to have been the first by the manner in which *Moses* has mentioned it), and to have brought it to considerable perfection before *Joseph's* time, and to very great perfection afterwards, chiefly by his means, should yet have left no history of their affairs, not even of the great empire under *Sesac* or *Sesostris*, and his successors. For they had no public calamities sufficient in any measure to destroy all their records, till the time of *Cambyzes*; and the desolation under him being less in degree, shorter in duration, in a kingdom

kingdom of greater extent, and two generations later in time, than that of the *Jewish* state under *Nebuchadnezzar*, which yet did not destroy the *Jewish* records, could not have totally destroyed the *Egyptian* records had they been more early, and superior to the *Jews*, in the use of alphabetical writing. Even the *Greeks*, who had no alphabetical writing till six hundred years after the time of *Moses*, have given a better account of their affairs, than the *Egyptians*. It ought, however, to be remarked in this place, that if we suppose the *Jewish* history to have been recorded by the divine appointment and direction, which is highly probable, this will lessen the force of the present argument, but not quite destroy it.

Thirdly, The late reception of writing amongst the *Greeks*, is both an argument, that it did not exist in any other neighbouring nation before the time of *Moses*, and also is consistent with its being miraculously communicated to *him*, to be made use of for sacred purposes, and for the preservation of the history of the world, and true religion, amongst God's peculiar people the *Israelites*. I here suppose, that the art of writing was not known to the *Greeks*, till the time of *Cadmus*; and that he came into *Greece*, agreeably to Sir *Isaac Newton's* opinion, about the middle of *David's* reign. And indeed, unless the principal points of his chronology be admitted, it does not appear to me, that any *rationale* can be given of ancient times, the inventions that rose up in them, the establishment and duration of kingdoms, their mutual intercourses, &c.

For, First, If alphabetical writing was known upon the continent of *Asia* and *Africa* six hundred years before *Cadmus*, how could it be kept from the *Greeks* till his arrival amongst them, and then accommodated to the *Greek* tongue only very imperfectly? For the *Greeks* received but sixteen letters from him. The *Greek* tongue came itself perhaps from *Egypt*, in some measure

measure; and they who brought the language two generations before *Cadmus*, would have brought an exact method of writing it alphabetically, had they been possessed of any such. For it is not probable, that *Inachus*, and the colonies of *Egyptians* that came with him, and after him, should change their language entirely for that of the poor wandering *Cimmerians*, whom they found in *Greece*, since we see in fact, that the colonies of *Europeans* do sometimes teach the barbarous natives, where they go, an *European* language; but never change it for theirs.

Secondly, If alphabetical writing was given to *Moses* miraculously, it is easy to be conceived, that it should not arrive at *Greece* sooner than the time of *Cadmus*. For the *Jews* were a separate people, their priests kept the writings of *Moses* in the ark, *i. e.* the only alphabetical writings in the world; and must be some time before they could be ready and expert either in reading or writing: in their attempts to copy, it is probable they would make some mistakes, so as to fall short of the purity and perfection of the art, as communicated by God; the neighbouring nations feared and hated the *Israelites*, their religion, and their God; they had probably a picture-writing, or perhaps some imperfect method of denoting words, agreeably to what has been remarked above, which answered all purposes that seemed necessary to them; and thus the art of alphabetical writing might not transpire to any of the neighbouring nations till the time of *Eli*, when the ark, with the writings of *Moses* in it, was taken by the *Philistines*. For since the writings of *Moses* were not in the ark, when it was put into the temple by *Solomon*, it may be, that the *Philistines* kept them, and learnt from them the art of writing alphabetically, being now sufficiently prepared for it by such notions concerning it, as had transpired to them previously in their former intercourse with the *Israelites*. And thus the *Phœnicians*,

or *Philistines*, will have appeared the inventors of letters to the *Greeks*; and *Cadmus* may well be supposed to have been able to accommodate the *Phœnician* method of writing, in an imperfect manner, to the *Greek* language, about two generations after the taking of the ark. Thus also, when *Samuel* put the writings of *Moses* together, as they had been copied by the priests, or others, in the order in which they now stand in the Pentateuch, there would be some deviations from the original method of writing communicated to *Moses* by God; and these, with such as happened in after-times, particularly upon the return from the *Babylonish* captivity (when it is supposed by some, that even the original letters were changed), may have made the ancient method of writing the *Hebrew*, as the *Jews* practise it in their Bibles for the synagogues without points, so imperfect as not to appear to be of divine original. For the same reasons, the corruptions of the *Hebrew* language, or the language given to *Heber* or *Peleg*, at the confusion of tongues, before *Moses's* time, may incline us to think the *Hebrew* of the Pentateuch not sufficiently regular for a divine communication. Much is also to be ascribed to our own ignorance in both these cases. However, there is a wonderful simplicity and uniformity still left, both in the Biblical *Hebrew*, and in the manner of writing it without points; so great, as to appear to me superior to the invention of rude ancient times.

Fourthly, The order of the *Greek* and *Latin* alphabets, by being taken from that of the *Hebrew*, as we have it in the alphabetical psalms, bears testimony to the great antiquity of the *Hebrew* alphabet. It is to be observed here, that both the *Greek* and *Latin* alphabets coincide with the *Hebrew* alphabet, as much as with each other, or more; and that there is no other ancient alphabet remaining to be a competitor to the *Hebrew*.

Fifthly

Fifthly, The resolution of the complex articulate sounds of ancient languages into simple elements or letters, and then recomposing these complex sounds in writing them down alphabetically, seems to me, as observed above, too difficult a problem for ancient times; especially as they neither could see the use of it, nor conceive the practicability. It would have appeared to them a task of an infinite extent; they would never conceive, that so small a number of elements would be sufficient, even supposing they could first hit upon the design. It confirms this, that no barbarous nation has ever invented alphabetical writing for themselves. They continue ignorant of it till taught. However, let it be observed, on the other hand, that as the ancient languages were simple and narrow, the difficulty of analysing their complex sounds would be the less on that account.

Sixthly, Since the method of making and erecting the tabernacle was communicated by God to *Moses*, *Bazaleel*, and *Aboliab*, in a supernatural manner, we may more easily suppose the art of writing alphabetically to be a divine gift. But then it is some objection to this, that *Moses* has not mentioned it as a divine gift, at least not expressly.

Seventhly, The time of *Moses* appears to be a suitable one for such a gift, as human life was then, perhaps, just brought down to the present degree of shortness. Till *Moses's* time, the length of life had preserved the sacred traditions uncorrupted, either with or without the helps above-mentioned, at least in the line of *Abraham*; but then tradition began to be mixed with fables, and to lead to idolatry.

Eighthly, Alphabetical writing, by being introduced among the *Israelites* in the wilderness, would abolish hieroglyphical, and consequently cut off one source of idolatry. It would likewise make them superior to the *Egyptians*, their enemies, in the art of writing; who, perhaps, prided themselves much upon

upon account of their perfection in hieroglyphical writing, as they might also in their river, the wisdom of their policy, the comparative greatness of their kingdom, their magical arts, religious ceremonies, &c. For this would tend to the glory of the God of the *Israelites*, and the establishment of the true religion amongst them.

It may be objected here, that alphabetical writing was in use before the giving of the law at *Sinai*, since *Moses* was directed before this to write an account of the battle with *Amalek* in a book; also to write the names of the children of *Israel* upon the high priest's breast-plate, like the engravings of a signet. I answer, that both these may refer to a picture-writing, or to some improvement of it, whereby entire words were denoted, without being resolved into their simple sounds. The first might also be a prophetic intimation to *Moses*, however not understood by him when it was given, that he should be soon enabled to write in a much more complete manner than he, or his enemies the *Egyptians*, could at present.

The *Edomites* seem also to have had some kind of writing early, from the account which we have of their dukes in *Genesis*. But this might be only picture or verbal writing, explained to *Samuel* by some *Edomite*, at the time when he put together the writings of *Moses*: or they might learn writing from the *Israelites*, sooner than any other nation, as being nearly related in blood, and contiguous to them in situation.

The simplicity and uniformity of the *Arabic* tongue would also incline one to think that the inhabitants of *Arabia* had alphabetical writing early, this having a great tendency to preserve a fixed standard in a language. But the *Ishmaelites*, or *Midianites*, who were nearly related to the *Israelites*, or the *Kenites*, who lived amongst them, might learn it from them, perhaps even during their abode in the wilderness. We may observe also, that the *Arabic*
tongue

tongue was not only fixed, but perhaps rendered more regular, soon after the time of *Mahomet*, by means of the *Alcoran*, and of the grammars that were made for this language some time afterwards; and that, before *Mahomet's* time the *Arabians* had little communication with their neighbours, and therefore would preserve their language more pure and simple.

The changes which have happened to languages, and to the methods of writing them since the invention of letters, and which are treated of with great copiousness in the writings of grammarians and critics, afford innumerable attestations to the doctrine of association, and may, conversely, be much illustrated by it. But the full detail of this must be left to those, who are well skilled in the several ancient and modern languages.

P R O P. LXXXIV.

To explain the general Nature of a philosophical Language, and hint some Methods, in which it might be constructed, upon the foregoing Principles.

If we suppose mankind possessed of such a language, as that they could at pleasure denote all their conceptions adequately, *i. e.* without any deficiency, superfluity, or equivocation; if, moreover, this language depended upon a few principles assumed, not arbitrarily, but because they were the shortest and best possible, and grew on from the same principles indefinitely, so as to correspond to every advancement in the knowledge of things, this language might be termed a philosophical one, and would as much exceed any of the present languages, as a paradisiacal state does the mixture of happiness and misery, which has been our portion ever since the fall. And it is
no

no improbable supposition, that the language given by God to *Adam* and *Eve*, before the fall, was of this kind; and, though it might be narrow, answered all their exigencies perfectly well.

Now there are several methods, in which it does not seem impossible for mankind in future ages to accomplish so great a design.

Thus, First, They may examine all the possible simple articulations of which their organs are capable, with all the combinations, or complex articulate sounds, that result from them, and the relations which these bear one to another, and assign to each respectively such simple and complex ideas, and such variations of the last, as a deep insight into the nature of things, objects, ideas, the powers of the human mind, &c. shall demand by a natural claim, so as to make every expression the shortest and best possible. And though this, in our present state of ignorance, cannot but seem an impracticable project, yet the same ignorance should teach us, that we can form no notions at all of the great increase of knowledge, which may come in future ages, and which seems promised to come in the latter happy times predicted by the prophecies. However, the great, and to former times inconceivable, advancement of knowledge, which has been made in the two last centuries, may help a little to qualify our prejudices.

Secondly, If all the simple articulate sounds, with all the radical words, which are found in the present languages, were appropriated to objects and ideas agreeably to the present senses of words, and their fitness to represent objects and ideas, so as to make all consistent with itself; if, farther, the best rules of etymology and syntax were selected from the present languages, and applied to the radical words here spoken of, so as to render them capable of expressing all the variations in objects and ideas, as far as possible, *i. e.* so as to grow proportionably to the growth

of knowledge, this might also be termed a philosophical language; and, though more imperfect and narrow than the last, yet seems more possible to be brought to execution and practice.

Thirdly, If such simple articulations as are now wanting in the *Hebrew* alphabet were added to it, and its radical words, composed of all the combinations of twos and threes completed, proper simple senses being assigned to them, from other languages suppose, and particularly from the *Arabic*, *Chaldee*, *Syriac*, and *Samaritan*, as in *Castellus's* Lexicon, and other books of a like kind; if, farther, such new rules of etymology and syntax were added to those which take place at present in the Biblical *Hebrew*, as this increase of the radicals, and application of the language to the whole aggregate of objects and ideas requires; we should have a much more simple, precise and extensive language, than any now in being. It would also be easy to be understood by the *Jews* in all quarters of the world. For most of them have some knowledge of the Biblical *Hebrew*, and many understand the Rabbinical, which seems to be formed upon a plan not very unlike that here proposed, though without any express design; and to which, therefore, a due regard ought to be had by any one, who should attempt to execute this plan. Many eastern nations, and the *Mahometans* every where, would also be expert in learning this language, from the relation and resemblance which it would bear to languages already known by them; and it would be easier to be learnt by perfect novices than any other, on account of its greater simplicity and regularity. A dictionary might be made for it in itself; the Biblical *Hebrew*, where its sense is determinate and known, being the basis, or thing given.

In the mean time, where the writer endeavours to express himself with plainness, sincerity, and precision,

cision, being first duly qualified by the knowledge of his subject, and the reader pays a due regard to him, as his teacher, for the then present time, by using sufficient industry and candour, the ill effects of the confusion of tongues become evanescent in respect of them. But it would be happy to take away all occasion of mistake from the bulk of mankind, and to give them an opportunity of learning important truths with more ease and certainty, and in a shorter time, than they can at present.

It may not be amiss to add here, that Mr. Byrom's method of short-hand affords an accurate and elegant instance of the possibility of proceeding in such matters upon simple and philosophical principles; his short-hand being a real and adequate representation of the sounds of the *English* tongue, as far as is necessary for determining the sense, and that in the shortest manner possible. If we were possessed of a philosophical language, it ought to be denoted by this character, *mutatis mutandis*.

P R O P. LXXXV.

To illustrate and confirm the general Doctrine of Association by the particular Associations, that take Place in respect of Language.

THIS has been done, in great measure, already, in the corollaries to the twelfth proposition. I will here insert some observations of a like kind, which would have interrupted the reader too much in their place, but may properly follow the account of language given in this section.

Let *a, b, c, d, &c.* the several letters of an alphabet, supposed to be sufficiently extensive for the purpose, represent respectively the several simple sensible pleasures and pains, to which a child becomes subject upon its first entrance into the world. The

will the various combinations of these letters represent the various combinations of pleasures and pains, formed by the events and incidents of human life; and, if we suppose them to be also the words of a language, this language will be an emblem or shadow of our passage through the present life; the several particulars in this being represented by analogous ones in that.

Thus the reiterated impressions of the simple sensible pleasures and pains made upon the child, so as to leave their miniatures, or ideas, are denoted by his learning the alphabet; and his various associations of these ideas, and of the pleasures and pains themselves, by his putting letters and syllables together, in order to make words: and when association has so far cemented the component parts of any aggregate of ideas, pleasures and pains, together, as that they appear one indivisible idea, pleasure or pain, the child must be supposed by an analogous association to have learnt to read without spelling.

As the child's words become more and more polysyllabic by composition and decomposition, till at length whole clusters run together into phrases and sentences, all whose parts occur at once, as it were, to the memory, so his pleasures and pains become more and more complex by the combining of combinations; and in many cases numerous combinations concur to form one apparently simple pleasure.

The several relations of words, as derived from the same root, as having the same prepositions and terminations, &c. represent corresponding relations in the compound ideas, pleasures and pains.

When the complex pleasures and pains, formed from miniatures of the sensible ones, become the means of gaining other and greater pleasures, viz. by building from frequent repetition, and so becoming mere ideas, or by any other method, we must suppose, that

that our present knowledge in language is used as a means of attaining farther knowledge in it.

As the sight and sound of words, impressed upon us on common occasions, do not at all suggest the original of these words from simple letters, this being a light in which grammarians and linguists alone consider words, so the complex pleasures and pains may pass over men's minds, and be felt daily, and yet not be considered by them as mere combinations, unless they be peculiarly attentive and inquisitive in this respect.

This comparison may serve as a method of assisting the reader's conceptions, in respect of the manner in which combinations of miniatures are formed. It is also a considerable evidence in favour of the general doctrine of association, since language is not only a type of these associated combinations, but one part of the thing typified. Was human life perfect, our happiness in it would be properly represented by that accurate knowledge of things which a truly philosophical language would give us. And if we suppose a number of persons thus making a progress in pure unmixed happiness, and capable both of expressing their own feelings, and of understanding those of others, by means of a perfect and adequate language, they might be like new senses and powers of perception to each other, and both give to and receive from each other happiness indefinitely. But as human life is, in fact, a mixture of happiness and misery, so all our languages must, from the difference of our associations, convey falsehood as well as truth, as above noted. And yet, since our imperfect languages improve, purify, and correct themselves perpetually by themselves, and by other means, so that we may hope at last to obtain a language, which shall be an adequate representation of ideas, and a pure channel of conveyance for truth

alone

alone, analogy seems to suggest, that the mixture of pleasures and pains, which we now experience, will gradually tend to a collection of pure pleasures only, and that association may be the means of effecting this, as remarked in the ninth corollary of the fourteenth proposition.

S C H O L I U M.

Musical sounds afford, like articulate ones, various instances of the power of association. It ought to be remarked here also, that the concords formed from the twelve semitones in the octave, are more in number than the discords; and that the harshness of these last passes by degrees into the limits of pleasure, partly from frequent repetition, partly from their associations with concords.

The doctrine of association may likewise be illustrated by that of colours. Thus, let the seven primary colours, with their shades, represent the original sensible pleasures; then will the various associated pleasures of human life, supposing that we enjoyed a state of unmixed happiness, be represented by the compound vivid colours, which natural bodies, of regular makes, and strong powers of reflection, exhibit to the eye. White, which is compounded of all the colours reflected copiously, and which yet, as far as the eye can discern, bears no resemblance to any of them, would represent a state of great mental happiness, ultimately deduced from all the sensible pleasures, and in which notwithstanding, the person himself distinguishes no traces of any of these. And, agreeably to this, light, brightness, and whiteness, are often put for perfection, purity, and happiness, as obscurity, blackness, and darkness, are for imperfection and misery. Besides white, there are other compound colours, which bear little or no resemblance to any of the primary ones, as well as

many in which some primary colour is evidently predominant. These represent the several kinds and degrees of inferior compound pleasures, some of which are, according to common estimation, quite foreign to the senses, whilst others are manifestly tinged with pleasant sensations, and their miniatures.

If the moderate agitations which light causes in bodies, when it is by them reflected back upon, or transmitted to other bodies, be supposed to correspond to pleasant vibrations in the nervous system; and the greater agitations, which it excites in those that absorb it, to the violent vibrations in which pain consists; then the colours of natural bodies, some of which incline to light, and some to darkness, and that with all the possible varieties and mixtures of the primary colours, may be considered as the language by which they express that mixture of pleasures and pains in human life, to which their agitations are supposed to correspond. And here again we may observe, that though there are some natural bodies, which absorb and stifle within themselves almost all the light which they receive, and which accordingly are dark, black and unpleasant to the beholders, yet the greatest part of natural bodies either reflect lively colours, or reflect some, and transmit others, or transmit all the colours freely. And this type is also, in part, the thing typified, inasmuch as agreeable and disagreeable colours make part of the original pleasures and pains of human life.

Compound tastes may likewise illustrate association; as above noted under the twelfth proposition for where the number of ingredients is very great as in Venice treacle, no one can be tasted distinctly whence the compound appears to bear no relation to its component parts. It is to be observed farther that ingredients which are separately disagreeable, often enter compounds, whose tastes are highly agreeable. Now in these cases either the opposite taste

must coalesce into one, which pleases from the preponderance of agreeable tastes upon the whole, as soon as the association is cemented sufficiently, or else the disagreeable tastes must, by frequent repetition, fall within the limits of pleasure at last; which seems rather to be the truth.

The similarity of the three instances of this scholium arises from the analogy of our senses to each other, and to our frame in general; which is the sum total of all our senses. And, conversely, they confirm this analogy.

Read to the

S E C T. II.

OF PROPOSITIONS, AND THE NATURE
OF ASSENT.

P R O P. LXXXVI.

To explain the Nature of Assent and Dissent, and to shew from what Causes they arise.

IT appears from the whole tenor of the last section, that assent and dissent, whatever their precise and particular nature may be, must come under the notion of ideas, being only those very complex internal feelings, which adhere by association to such clusters of words as are called *propositions* in general, or affirmations and negations in particular. The same thing is remarked in the tenth corollary to the twelfth proposition.

But in order to penetrate farther into this difficult and important point, I will distinguish assent (and by consequence its opposite, dissent) into two kinds, rational and practical; and define each of these.

Rational assent then to any proposition may be defined a readiness to affirm it to be true, proceeding from a close association of the ideas suggested by the proposition, with the idea, or internal feeling, belonging to the word truth; or of the terms of the proposition with the word truth. Rational dissent is the opposite to this. This assent might be called verbal; but as every person supposes himself always to have sufficient reason for such readiness to affirm or deny, I rather choose to call it rational.

Practical assent is a readiness to act in such manner as the frequent vivid recurrency of the rational assent

assent disposes us to act ; and practical dissent the contrary.

Practical assent is therefore the natural and necessary consequence of rational, when sufficiently impressed. There are, however, two cautions to be subjoined here, viz. First, That some propositions, mathematical ones for instance, admit only of a rational assent, the practical not being applied to them in common cases. Secondly, That the practical assent is sometimes generated, and arrives at a high degree of strength, without any previous rational assent, and by methods that have little or no connection with it. Yet still it is, in general, much influenced by it, and, conversely, exerts a great influence upon it. All this will appear more clearly when we come to the instances.

Let us next inquire into the causes of rational and practical assent, beginning with that given to mathematical conclusions.

Now the cause that a person affirms the truth of the proposition, *twice two is four*, is the entire coincidence of the visible or tangible idea of twice two with that of four, as impressed upon the mind by various objects. We see every where, that twice two and four are only different names for the same impression. And it is mere association which appropriates the word truth, its definition, or its internal feeling, to this coincidence.

Where the numbers are so large, that we are not able to form any distinct visible ideas of them, as when we say, that 12 times 12 is equal to 144; a coincidence of the words arising from some method of reckoning up 12 times 12, so as to conclude with 144, and resembling the coincidence of words which attends the just-mentioned coincidence of ideas in the simpler numerical propositions, is the foundation of our rational assent. For we often do, and might always verify the simplest numerical propositions by

reckoning up the numbers. The operations of addition, subtraction, multiplication, division, and extraction of roots, with all the most complex ones relating to algebraic quantities, considered as the exponents of numbers, are no more than methods of producing this coincidence of words, founded upon and rising above one another. And it is mere association again, which appropriates the word truth to the coincidence of the words, or symbols, that denote the numbers.

It is to be remarked, however, that this coincidence of words is, by those who look deeper into things, supposed to be a certain argument, that the visible ideas of the numbers under consideration, as of 12 times 12, and 144, would coincide, as much as the visible ideas of twice two and four, were they as clear and distinct. And thus the real and absolute truth is said by such persons to be as great in complex numerical propositions, as in the simplest. All this agrees with what Mr. *Locke* has observed concerning numbers, viz. that their names are necessary in order to our obtaining distinct ideas of them; for by distinct ideas he must be understood to mean proper methods of distinguishing them from one another, so as to reason justly upon them. He cannot mean distinct visible ideas.

In geometry there is a like coincidence of lines, angles, spaces, and solid contents, in order to prove them equal in simple cases. Afterwards, in complex cases, we substitute the terms whereby equal things are denoted for each other, also the coincidence of the terms, for that of the visible ideas, except in the new step advanced in the proposition; and thus get a new equality, denoted by a new coincidence of terms. This resembles the addition of unity to any number, in order to make the next, as of 1 to 20 in order to make 21. We have no distinct visible idea, either of 20 or 21; but we have of the differ-

ence

ence between them, by fancying to ourselves a confused heap of things supposed or called 20 in number; and then farther fancying 1 to be added to it. By a like process in geometry we arrive at the demonstration of the most complex propositions.

The properties of numbers are applied to geometry in many cases, as when we demonstrate a line or space to be half or double of any other, or in any other rational proportion to it.

And as in arithmetic words stand for indistinct ideas, in order to help us to reason upon them as accurately as if they were distinct; also cyphers for words, and letters for cyphers, both for the same purpose; so letters are put for geometrical quantities also, and the agreements of the first for those of the last. And thus we see the foundation upon which the whole doctrine of quantity is built; for all quantity is expounded either by number or extension, and their common and sole exponent is algebra. The coincidence of ideas is the foundation of the rational assent in simple cases; and that of ideas and terms together, or of terms alone, in complex ones. This is upon supposition that the quantities under consideration are to be proved equal. But, if they are to be proved unequal, the want of coincidence answers the same purpose. If they are in any numeral ratio, this is only the introduction of a new coincidence. Thus, if, instead of proving A to be equal to B , we are to prove it equal to half B , the two parts of B must coincide with each other, either in idea or terms, and A with one.

And thus it appears, that the use of words is necessary for geometrical and algebraical reasonings, as well as for arithmetical.

We may see also, that association prevails in every part of the processes hitherto described.

But these are not the only causes of giving rational assent to mathematical propositions, as this is defined

above. The memory of having once examined and assented to each step of a demonstration, the authority of an approved writer, &c. are sufficient to gain our assent, though we understand no more than the import of the proposition; nay, even though we do not proceed so far as this. Now this is mere association again; this memory, authority, &c. being, in innumerable instances, associated with the before-mentioned coincidence of ideas and terms.

But here a new circumstance arises. For memory and authority are sometimes found to mislead; and this opposite coincidence of terms puts the mind into a state of doubt, so that sometimes truth may recur, and unite itself with the proposition under consideration, sometimes falsehood, according as the memory, authority, &c. in all their peculiar circumstances, have been associated with truth or falsehood. However, the foundation of assent is still the same. I here describe the fact only. And yet, since this fact must always follow from the fixed immutable laws of our frame, the obligation to assent (whatever be meant by this phrase) must coincide with the fact.

And thus a mathematical proposition, with the rational assent or dissent arising in the mind, as soon as it is presented to it, is nothing more than a group of ideas, united by association, *i. e.* than a very complex idea, as was affirmed above of propositions in general. And this idea is not merely the sum of the ideas belonging to the terms of the proposition, but also includes the ideas, or internal feelings, whatever they be, which belong to equality, coincidence, truth, and, in some cases, those of utility, importance, &c.

For mathematical propositions are, in some cases, attend with a practical assent, in the proper sense of these words; as when a person takes this or that method of executing a projected design, in consequence of some mathematical proposition assented to

from

from his own examination, or on the authority of others. Now, that which produces the train of voluntary actions, here denoting the practical assent, is the frequent recurrency of ideas of utility and importance. These operate according to the method laid down in the twentieth proposition, *i. e.* by association; and though the rational assent be a previous requisite, yet the degree of the practical assent is proportional to the vividness of these ideas; and in most cases they strengthen the rational assent by a reflex operation.

Propositions concerning natural bodies are of two kinds, vulgar and scientific. Of the first kind are, *that milk is white, gold yellow, that a dog barks, &c.* These are evidently nothing but forming the present complex idea belonging to material objects into a proposition, or adding some of its common associates, so as to make it more complex. There is scarce room for dissent in such propositions, they being all taken from common appearances. Or if any doubt should arise, the matter must be considered scientifically. The assent given to these propositions arises from the associations of the terms, as well as of the ideas denoted by them.

In scientific propositions concerning natural bodies a definition is made, as of gold from its properties, suppose its colour, and specific gravity, and another property or power joined to them, as a constant or common associate. Thus gold is said to be ductile, fixed, or soluble in *aqua regia*. Now to persons, who have made the proper experiments a sufficient number of times, these words suggest the ideas which occur in those experiments, and, conversely, are suggested to them, in the same manner as the vulgar propositions above-mentioned suggest and are suggested by common appearances. But when, if they be scientific persons, their readiness to affirm, that gold is soluble in *aqua regia* universally, arises

arises also from the experiments of others, and from their own and other's observations on the constancy and tenor of nature. They know, that the colour, and specific gravity, or almost any two or three remarkable qualities of any natural body, infer the rest, being never found without them. This is a general truth; and as these general terms are observed to coincide, in fact, in a great variety of instances, so they coincide at once in the imagination, when applied to gold, or any other natural body, in particular. The coincidence of general terms is also observed to infer that of the particular cases in many instances, besides those of natural bodies; and this unites the subject and predicate of the proposition, *gold is soluble in aqua regia*, farther in those who penetrate still deeper into abstract speculations. And hence we may see, as before, First, That terms or words are absolutely necessary to the art of reasoning: Secondly, That our assent is here also, in every step of the process, deducible from association.

The propositions formed concerning natural bodies are often attended with a high degree of practical assent, arising chiefly from some supposed utility and importance, and which is no ways proportional to the foregoing, or other such like allowed causes of rational assent. And in some cases the practical assent takes place before the rational. But then, after some time, the rational assent is generated and cemented most firmly by the prevalence of the practical. This process is particularly observable in the regards paid to medicines, *i. e.* in the rational and practical assent to the propositions concerning their virtues.

It is to be observed, that children, novices, unlearned persons, &c. give, in many cases, a practical assent upon a single instance; and that this arises from the first and simplest of the associations here considered. The influence of the practical assent over the rational arises plainly from their being joined together

her in so many cases. The vividness of the ideas arising from the supposed utility, importance, &c. does also unite the subject and predicate sooner and closer, agreeably to what has been observed in the general account of association.

The evidences for past facts are a man's own memory, and the authority of others. These are the usual associates of true past facts, under proper restrictions, and therefore beget the readiness to affirm a past fact to be true, *i. e.* the rational assent. The integrity and knowledge of the witnesses, being the principal restriction, or requisite, in the accounts of past facts, become principal associates to the assent to them; and the contrary qualities to dissent.

If it be asked, how a narration of an event, supposed to be certainly true, supposed doubtful, or supposed entirely fictitious, differs in its effect upon the mind, in the three circumstances here alleged, the words being the same in each, I answer, first, in having the terms *true*, *doubtful*, and *fictitious*, with a variety of usual associates to these, and the corresponding internal feelings of respect, anxiety, dislike, &c. connected with them respectively; whence the whole effects, exerted by each upon the mind, will differ considerably from one another. Secondly, If the event be of an interesting nature, as a great advantage accruing, the death of a near friend, the affecting related ideas will recur oftener, and, by so recurring agitate the mind more, in proportion to the supposed truth of the event. And it confirms this, that the frequent recurrency of an interesting event, supposed doubtful, or even fictitious, does, by degrees, make it appear like a real one, as in reveries, reading romances, seeing plays, &c. This affection of mind may be called the practical assent to past facts; and it frequently draws after it the rational, as in the other instances above alleged.

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The evidence for future facts is of the same kind with that for the propositions concerning natural bodies, being like it, taken from induction and analogy. This is the cause of the rational assent. The practical depends upon the recurrency of the ideas, and the degree of agitation produced by them in the mind. Hence reflection makes the practical assent grow for a long time after the rational is arisen to its height; or if the practical arises without the rational, in any considerable degree, which is often the case, it will generate the rational. Thus the sanguine are apt to believe and assert what they hope, and the timorous what they fear.

There are many speculative, abstracted propositions in logic, metaphysics, ethics, controversial divinity, &c. the evidence for which is the coincidence or analogy of the abstract terms, in certain particular applications of them, or as considered in their grammatical relations. This causes the rational assent. As to the practical assent or dissent, it arises from the ideas of importance, reverence, piety, duty, ambition, jealousy, envy, self-interest, &c. which intermix themselves in these subjects, and, by doing so, in some cases add great strength to the rational assent; in others, destroy it, and convert it into its opposite.

And thus it appears, that rational assent has different causes in propositions of different kinds, and practical likewise; that the causes of rational are also different from those of practical; that there is however, a great affinity, and general resemblance, in all the causes; that rational and practical assent exert a perpetual reciprocal effect upon one another; and consequently, that the ideas belonging to assent and dissent, and their equivalents and relatives, are highly complex ones, unless in the cases of very simple propositions, such as mathematical ones. For,

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besides the coincidence of ideas and terms, they include, in other cases, ideas of utility, importance, respect, disrespect, ridicule, religious affections, hope, fear, &c. and bear some gross general proportion to the vividness of these ideas.

COR. 1. When a person says *video meliora proboque, deteriora sequor*; it shews that the rational and practical assent are at variance, that they have opposite causes, and that neither of these has yet destroyed the other.

COR. 2. The rational and practical faith in religious matters are excellent means of begetting each other.

COR. 3. Vicious men, *i. e.* all persons who want practical faith, must be prejudiced against the historical and other rational evidences in favour of revealed religion.

COR. 4. It is impossible any person should be so sceptical, as not to have the complex ideas denoted by assent and dissent associated with a great variety of propositions, in the same manner, as in other persons; just as he must have the same ideas in general affixed to the words of his native language, as other men have. A pretended sceptic is therefore no more than a person who varies from the common usage in his application of a certain set of words, viz. truth, certainty, assent, dissent, &c.

COR. 5. As there is a foundation for unity amongst mankind in the use and application of words, so there is for a unity in the assent, or complex ideas belonging to propositions; and a philosophical language, or any other method of bringing about the first unity, would much conduce to this. A careful examination of things, of the world natural, the human mind, the scriptures, would conduce much also. But candour simplicity, and an humble sense of our own ignorance, which may be called a religious or christian scepticism, is the principal requisite, and that

that without which this part of the confusion at *Babel* can never be remedied. When religion has equally and fully absorbed different persons, so that God is, in respect of them, *all in all*, as far as the present condition of mortality will permit, their practical assent must be the same; and therefore their rational cannot differ long or widely.

The ideas and internal feelings which arise in the mind, from words and propositions, may be compared to, and illustrated by, those which the appearances of different persons excite. Suppose two persons, *A* and *B*, to go together into a crowd, and there each of them to see a variety of persons whom he knew in different degrees, as well as many utter strangers. *A* would not have the same ideas, and associations raised in him from viewing the several faces, dresses, &c. of the persons in the crowd, as *B*, partly from his having a different knowledge of, and acquaintance with them; partly from different predispositions to approve and disapprove. But let *A* and *B* become equally acquainted with them, and acquire, by education and association, the same predispositions of mind, and then they will at last make the same judgment of each of the persons whom they see.

COR. 6. Religious controversies concerning abstract propositions arise generally from the different degrees of respect paid to terms and phrases which conduce little or nothing to the generation of practical faith, or of love to God, and trust in him through Christ.

P R O P. LXXXVII.

To deduce Rules for the Ascertainment of Truth, and Advancement of Knowledge, from the mathematical Methods of considering Quantity.

THIS is done in the doctrine of chances, with respect to the events there considered. And though we seldom have such precise *data*, in mixed sciences as are there assumed, yet there are two remarks of very general use and application, deducible from the doctrine of chances.

Thus, First, If the evidences brought for any proposition, fact, &c. be dependent on each other, so that the first is required to support the second, the second to support the third, &c. *i. e.* if a failure of any one of the evidences renders all the rest of no value, the separate probability of each evidence must be very great, in order to make the proposition credible; and this holds so much the more, as the dependent evidences are more numerous. For instance, if the value of each evidence be $\frac{1}{a}$, and the number of evidences be n , then will the resulting probability be $\frac{1}{a^n}$. I here suppose absolute certainty to be denoted by 1; and consequently, that a can never be less than 1. Now it is evident, that $\frac{1}{a^n}$ decreases with every increase both of a and n .

Secondly, If the evidences brought for any proposition, fact, &c. be independent on each other, *i. e.* if they be not necessary to support each other, but concur, and can, each of them, when established upon its own proper evidences, be applied directly to establish the proposition, fact, &c. in question, the deficiency in the probability of each must be very great,

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in order to render the proposition perceptibly doubtful; and this holds so much the more, as the evidences are more numerous. For instance, if the evidences be all equal, and the common deficiency in each be $\frac{1}{a}$, if also the number of evidences be n as before, the deficiency of the resulting probability will be no more than $\frac{1}{a^n}$, which is practically nothing, where a and n are considerable. Thus if a and n be each equal to 10, $\frac{1}{a^n}$ will be $\frac{1}{10,000,000,000}$, or only 1 in ten thousand millions; a deficiency from certainty, which is utterly imperceptible to the human mind.

It is indeed evident, without having recourse to the doctrine of chances, that the dependency of evidences makes the resulting probability weak, their independency strong. Thus a report passing from one original author through a variety of successive hands loses much of its credibility, and one attested by a variety of original witnesses gains, in both cases, according to the number of successive reporters, and original witnesses, though by no means proportionably thereto. This is the common judgment of mankind, verified by observation and experience. But the mathematical method of considering these things is much more precise and satisfactory, and differs from the common one, just as the judgment made of the degrees of heat by the thermometer does from that made by the hand.

We may thus also see in a shorter and simpler way that the resulting probability may be sufficiently strong in dependent evidences, and of little value in independent ones, according as the separate probability of each evidence is greater or less. Thus the principal facts of ancient history are not less probable practically now, than ten or fifteen centuries ago, nor less so then

then, than in the times immediately succeeding; because the diminution of evidence in each century is imperceptible. For, if $\frac{1}{a}$ be equal to 1, $\frac{1}{a^n}$ will be equal to 1 also; and if the deficiency of $\frac{1}{a}$ from 1 be extremely small, that of $\frac{1}{a^n}$ will be extremely small also, unless n be extremely great. And for the same reason a large number of weak arguments proves little; for $\frac{1}{a}$, the deficiency of each argument, being extremely great, $\frac{1}{a^n}$, the resulting deficiency of independent evidences, will be extremely great also.

It appears likewise, that the inequality of the separate evidences does not much affect this reasoning. In like manner, if the number of evidences, dependent or independent, be great, we may make great concessions as to the separate values of each. Again, a strong evidence in dependent ones can add nothing, but must weaken a little; and, after a point is well settled by a number of independent ones, all that come afterwards are useless, because they can do no more than remove the imperceptible remaining deficiency, &c. And it will be of great use to pursue these, and such like deductions, both mathematically, and by applying them to proper instances selected from the sciences, and from common life, in order to remove certain prejudices, which the use of general terms, and ways of speaking, with the various associations adhering to them, is apt to introduce and fix upon the mind. It cannot but assist us in the art of reasoning, thus to take to pieces, recompose, and ascertain our evidences.

If it be asked, upon what authority absolute certainty is represented by unity, and the several degrees

of probability by fractions less than unity, in the doctrine of chances? Also, upon what authority the reasoning used in that doctrine is transferred to other subjects, and made general, as here proposed? I answer, that no person who weighs these matters carefully, can avoid giving his assent; and that this precludes all objections. No sceptic would, in fact, be so absurd as to lay 2 to 1, where the doctrine of chances determines the probability to be equal on each side; and therefore we may be sure, that he gives a practical assent at least to the doctrine of chances.

Mr. *de Moivre* has shewn, that where the causes of the happening of an event bear a fixed ratio to those of its failure, the happenings must bear nearly the same ratio to the failures, if the number of trials be sufficient; and that the last ratio approaches to the first indefinitely, as the number of trials increases. This may be considered as an elegant method of accounting for that order and proportion, which we every where see in the phænomena of nature. The determinate shapes, sizes, and mutual actions of the constituent particles of matter, fix the ratios between the causes for the happenings, and the failures; and therefore it is highly probable, and even necessary, as one may say, that the happenings and failures should perpetually recur in the same ratio to each other nearly, while the circumstances are the same. When the circumstances are altered, then new causes take place; and consequently there must be a new, but fixed ratio, between the happenings and the failures. Let the first circumstances be called *A*, the new ones *B*. If now the supposition be made so general, as equally to take in both *A* and *B*, the ratio of the happenings and failures will not be such as either *A* or *B* required. But still it will tend to a preciseness, just as they did, since the sum

of the causes of the happenings must bear a fixed ratio to the sum of the causes of the failures.

An ingenious friend has communicated to me a solution of the inverse problem, in which he has shewn what the expectation is, when an event has happened p times, and failed q times, that the original ratio of the causes for the happening or failing of an event should deviate in any given degree from that of p to q . And it appears from this solution, that where the number of trials is very great, the deviation must be inconsiderable: which shews that we may hope to determine the proportions, and, by degrees, the whole nature, of unknown causes, by a sufficient observation of their effects.

The inferences here drawn from these two problems are evident to attentive persons, in a gross general way, from common methods of reasoning.

Let us, in the next place, consider the *Newtonian* differential method, and compare it with that of arguing from experiments and observations, by induction and analogy. This differential method teaches, having a certain number of the ordinates of any unknown curve given with the points of the absciss on which they stand, to find out such a general law for this curve, *i. e.* such an equation expressing the relation of an ordinate and absciss in all magnitudes of the absciss, as will suit the ordinates and points of the absciss given, in the unknown curve under consideration. Now here we may suppose the given ordinates standing upon given points to be analogous to effects, or the results of various experiments in given circumstances, the absciss analogous to all possible circumstances, and the equation afforded by the differential method to that law of action, which, being supposed to take place in the given circumstances, produces the given effects. And as the use of the differential method is to find the lengths of ordinates not given, standing upon points of the absciss that

are given, by means of the equation, so the use of attempts to make general conclusions by induction and analogy, from particular effects or phænomena, is to enable us to predict other phænomena in different given circumstances, by applying the general law or conclusion to these circumstances.

This parallel is the more pertinent and instructive, inasmuch as the mathematical conclusion drawn by the differential method, though formed in a way that is strictly just, and so as to have the greatest possible probability in its favour, is, however liable to the same uncertainties, both in kind and degree, as the general maxims of natural philosophy drawn from natural history, experiments, &c.

If many ordinates be given; if the distances of the points of the absciss, on which they stand, be equal and small; if the ordinate required lie amongst them, or near them; and if there be reason to think, that the curve itself is formed according to some simple, though unknown law; then may we conclude, that the new ordinate, determined by the equation, does not vary far from the truth. And if the resulting equation be simple, and always the same, from whatever given ordinates it be extracted, there is the greatest reason to think this to be the real original law or equation of the curve; and consequently that all its points and properties may be determined with perfect exactness by means of it: whereas, if the given ordinates be few, their distances great or unequal, the ordinate required considerably distant from many or most of them, the unknown curve be a line drawn at hazard, and the resulting equation very different where different ordinates are given, though their number be the same, there will be little probability of determining the new ordinate with exactness; however still the differential method affords us the greatest probability which the *data* permit in such cases.

In like manner, if the experiments or observations be many, their circumstances nearly related to each other, and in a regular series, the circumstances of the effect to be investigated nearly related to them; also, if the real cause may be supposed to produce these effects, by the varieties of some simple law, the method of induction and analogy will carry great probability with it. And if the general conclusion or law be simple, and always the same, from whatever phænomena it be deduced, such as the three laws of nature, the doctrines of gravitation, and of the different refrangibility of light; or, to go still higher, by taking a mathematical instance, the law for finding the coefficients of the integral powers of a binomial, deduced from mere trials in various powers; there can scarce remain any doubt, but that we are in possession of the true law inquired after, so as to be able to predict with certainty, in all cases where we are masters of the method of computation, or applying it; and have no reason to suspect, that other unknown laws interfere. But, if the given phænomena be few, their circumstances very different from each other, and from those of the effect to be predicted; if there be reason to suppose, that many causes concur in the producing these phænomena, so that the law of their production must be very complex; if a new hypothesis be required to account for every new combination of these phænomena; or, at least, one that differs considerably from itself; the best hypothesis which we can form, *i. e.* the hypothesis which is most conformable to all the phænomena, will amount to no more than an uncertain conjecture; and yet still it ought to be preferred to all others, as being the best that we can form.

That instantaneous and necessary coalescence of ideas, which makes intuitive evidence, may be considered as the highest kind of induction, and as amounting to a perfect coincidence of the effect concluded

with those from which it is concluded. This takes place only in mathematics. Thus we infer, that 2 and 2 make 4, only from prior instances of having actually perceived this, and from the necessary coincidence of all these instances with all other possible ones of 2 and 2. Mathematical demonstrations are made up of a number of these, as was observed above.

Where the instances from whence the induction is made are alike, as far as we know, to that under consideration, at least in all things that affect the present inquiry, it affords the highest probability, and may be termed induction, in the proper sense of the word. Thus we infer, that the bread before us is nutritive and wholesome, because its smell, taste, ingredients, manner of composition, &c. are the same as those of other bread, which has often before been experienced to be so.

But, if the instance under consideration be in some respects like the foregoing ones, in others not, this kind of proof is generally termed one taken from analogy. Thus, if we argue from the use and action of the stomach in one animal to those in another, supposed to be unknown, there will be a probable hazard of being mistaken, proportional in general to the known difference of the two animals, as well as a probable evidence for the truth of part, at least, of what is advanced, proportional to the general resemblance of the two animals. But if, upon examination, the stomach, way of feeding, &c. of the second animal should be found, to sense, the same as in the first, the analogy might be considered as an induction properly so called, at least as approaching to it; for precise limits cannot be fixed here. If the second animal be of the same species, also of the same age, sex, &c. with the first, the induction becomes perpetually of a higher and a higher order, approaching more and more to the coincidence, which

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obtains in mathematical evidences, and yet never being able entirely to arrive at it. But then the difference, being only an infinitesimal fraction, as it were, becomes nothing to all practical purposes whatsoever. And if a man considers farther, that it would be hard to find a demonstration, that he does not mistake the plainest truths; this lessens the difference theoretically also.

It is often in our power to obtain an analogy where we cannot have an induction; in which case reasoning from analogy ought to be admitted; however, with all that uncertainty which properly belongs to it, considered as more or less distant from induction, as built upon more or fewer dependent or independent evidences, &c. analogy may also in all cases, be made use of as a guide to the invention. But coincidence in mathematical matters, and induction in others, wherever they can be had, must be sought for as the only certain tests of truth. However, induction seems to be a very sufficient evidence in some mathematical points, affording at least as much evidence there as in natural philosophy; and may be safely relied on in perplexed cases, such as complex serieses, till satisfactory demonstrations can be had.

The analogous natures of all the things about us, are a great assistance in decyphering their properties, powers, laws, &c. inasmuch as what is minute or obscure in one may be explained and illustrated by the analogous particular in another, where it is large and clear. And thus all things become comments on each other in an endless reciprocation.

When there are various arguments for the same thing taken from induction or analogy, they may all be considered as supporting one another in the same manner as independent evidences. Thus, if it could be shewed, that the human understanding is entirely dependent on association (as is remarked in this and the last section), the many analogies and

connections between the understanding and affections, as these terms are commonly understood and contradistinguished by writers, would make it very probable, that association precedes in the same manner in the generation of the affections; and *vice versa*. And the more analogies, and mutual connections, between the understanding and affections, were produced, so many more independent or concurrent evidences would there be for this prevalence of association in one, admitting it in the other. But, if now it be shewn farther, that the understanding and affections are not really distinct things, but only different names, which we give to the same kind of motions in the nervous system, on account of a difference in degree, and other differences which it would be tedious here to enumerate, but which make no difference in respect of the power of association, then all the arguments from analogy are transformed into one of induction; which, however, is stronger than the united force of them all. For now it may be shewed, that association must prevail in each motion in the brain, by which affection is expounded, from a large induction of particulars, in which it prevails in the generation of ideas, or of the motions by which they are expounded, and which we suppose to be proved to be of the same kind with those that expound the affections. Thus also inductions may be taken from the smell and taste of bread, to prove it wholesome; which would both be transformed into one simple argument stronger than both, could we see the internal constitution of the small parts of the bread, from whence its smell, and taste, and wholesomeness, are all derived. Thus, again, all the arguments of induction for the manner of extracting the square root in numbers vanish into the single demonstrative proof, as soon as this is produced. And the great business in all branches of knowledge is thus to reduce, unite, and simplify our evidences; so as

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that the one resulting proof, by being of a higher order, shall be more than equal in force to all the concurrent ones of the inferior orders.

Having now considered in what manner the doctrine of chances, and the *Newtonian* differential method, may serve to shew in general the value of dependent and independent or concurrent evidences, and the probability of general conclusions formed by induction and analogy; let us next inquire by what means we are to form these general conclusions, and discover their evidences. Now the different methods of doing this may be said to resemble respectively the rule of false in common arithmetic; the algebraic methods of bringing the unknown quantity into an equation, under a form capable of all the algebraic operations, addition, subtraction, &c. the algebraic methods of finding the roots of equations of the higher orders by approximation; and the art of decyphering: all which four methods bear also a considerable resemblance to each other. I will consider them in order, and endeavour to shew how analogous methods may be introduced into the sciences in general, to advantage.

First, then, As, according to the rule of false, the arithmetician supposes a certain number to be that which is sought for; treats it as if it was that; and finding the deficiency or overplus in the conclusion, rectifies the error of his first position by a proportional addition or subtraction, and thus solves the problem; so it is useful in inquiries of all kinds, to try all such suppositions as occur with any appearance of probability, to endeavour to deduce the real phenomena from them; and if they do not answer in some tolerable measure, to reject them at once; or if they do, to add, expunge, correct, and improve, till we have brought the hypothesis as near as we can to an agreement with nature. After this it must be left to be farther corrected and improved,
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or entirely disproved, by the light and evidence reflected upon it from the contiguous, and even, in some measure, from the remote branches of other sciences.

Were this method commonly used, we might soon expect a great advancement in the sciences. It would much abate that unreasonable fondness, which those who make few or no distinct hypotheses, have for such confused ones as occur accidentally to their imaginations, and recur afterwards by association. For the ideas, words, and reasonings, belonging to the favourite hypothesis, by recurring, and being much agitated in the brain, heat it, unite with each other, and so coalesce in the same manner, as genuine truths do from induction and analogy. Verbal and grammatical analogies and coincidences are advanced into real ones; and the words which pass often over the ear, in the form of subject and predicate, are from the influence of other associations made to adhere together insensibly, like subjects and predicates, that have a natural connection. It is in vain to bid an inquirer form no hypothesis. Every phænomenon will suggest something of this kind; and, if he does not take care to state such as occur fully and fairly, and adjust them one to another, he may entertain a confused inconsistent mixture of all, of fictitious and real, possible add impossible; and become so persuaded of it, as that counter associations shall not be able to break the unnatural bond. But he that forms hypotheses from the first, and tries them by the facts, soon rejects the most unlikely ones; and, being freed from these, is better qualified for the examination of those that are probable. He will also confute his own positions so often, as to fluctuate in equilibrio, in respect of prejudices, and so be at perfect liberty to follow the strongest evidences.

In like manner, the frequent attempts to make an hypothesis that shall suit the phænomena, must improve a man in the method of doing this, and beget

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in him by degrees an imperfect practical art, just as algebraists and decyphers, that are much versed in practice, are possessed of innumerable subordinate artifices, besides the principal general ones, that are taught by the established rules of their arts; and these, though of the greatest use to themselves, can scarce be explained or communicated to others. These artifices may properly be referred to the head of factitious sagacity, being the result of experience, and of impressions often repeated, with small variations from the general resemblance.

Lastly, The frequent making of hypotheses, and arguing from them synthetically, according to the several variations and combinations of which they are capable, would suggest numerous phænomena, that otherwise escape notice, and lead to *experimenta crucis*, not only in respect of the hypothesis under consideration, but of many others. The variations and combinations just mentioned suggest things to the invention which the imagination unassisted is far unequal to; just as it would be impossible for a man to write down all the changes upon eight bells, unless he had some method to direct him.

But this method of making definite hypotheses, and trying them, is far too laborious and mortifying for us to hope, that inquirers will in general pursue it. It would be of great use to such as intend to pursue it, to make hypotheses for the phænomena, whose theories are well ascertained; such as those of the circulation of the blood, of the pressure of the air, of the different refrangibility of the rays of light, &c. and see how they are gradually compelled into the right road, even from wrong suppositions fairly compared with the phænomena. This would habituate the mind to a right method, and beget the factitious sagacity above-mentioned.

The second of the four methods proposed is, that of bringing the unknown quantity to an equation, and putting it into a form susceptible of all the algebraic

gebraic operations. Now to this answers, in philosophy, the art of giving names, expressing nothing definite as to manner, quantity, &c. and then inserting these names, or indefinite terms, in all the enunciations of the phænomena, to see whether, from a comparison of these enunciations with each other, where the terms are used in the greatest latitude, some restrictions, something definite in manner, degree or mutual relation, will not result. Things that are quite unknown have often fixed relations to one another, and sometimes relations to things known, which, though not determinable with certainty and precision, may yet be determined in some probable manner, or within certain limits. Now, as in algebra it is impossible to express the relation of the unknown quantity to other quantities known or unknown, till it has a symbol assigned to it of the same kind with those that denote the others; so in philosophy we must give names to unknown quantities, qualities, causes, &c. not in order to rest in them, as the *Aristotelians* did, but to have a fixed expression, under which to treasure up all that can be known of the unknown cause, &c. in the imagination and memory, or in writing for future inquirers.

But then it is necessary for the same reasons, that these terms should have no more of secondary ideas from prior associations, than the terms x and y in algebra. Whence, if we use old terms excluding the old associations, the reader should be made aware of this at first, and incidentally reminded of it afterwards. Sir *Isaac Newton* has used the words *æther*, *attraction*, and some others, in this way, not resting in them, but enumerating a great variety of phænomena; from the due comparison of which with each other, and with such as farther observation and experiments shall suggest, their laws of action will, perhaps, be discovered hereafter; so that we may be able to predict the phænomena. There is also an instance

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instance of the proper manner of reasoning concerning the knowable relations of unknown things in Mr. Mede's *Clavis Apocalyptica*.

The third method is that of approximating to the roots of equations. Here a first position is obtained, which, though not accurate, approaches, however, to the truth. From this, applied to the equation, a second position is deduced, which approaches nearer to the truth than the first; from the second, a third, &c. till the analyst obtains the true root, or such an approximation as is practically equivalent, every preceding discovery being made the foundation for a subsequent one, and the equation resolving itself, as it were, gradually. Now this is indeed the way, in which all advances in science are carried on; and scientific persons are in general aware, that it is and must be so. However, I thought it not improper to illustrate this general process by a parallel taken from algebra, in which there is great exactness and beauty. Besides, writers do not often dispose their arguments and approximations in this way, though for want of it they lose much of their clearness and force; and, where the writer does this, the reader is frequently apt to overlook the order of proofs and positions.

Sir *Isaac Newton's* Optics, Chronology, and Comment on *Daniel*, abound with instances to this purpose; and it is probable, that his great abilities and practice in algebraic investigations led him to it insensibly. In his Chronology he first shews in gross, that the technical chronology of the ancient *Greeks* led them to carry their authorities higher than the truth; and then, that the time of the *Sesostris* mentioned by the *Greek* historians was near that of *Sesac* mentioned in the Old Testament; whence it follows, that these two persons were the same; and consequently, that the exact time of *Sesostris's* expedition may now be fixed by the Old Testament. And now,
having

having two points absolutely fixed, viz. the expeditions of *Sesostris* and *Xerxes*, he fixes all the most remarkable intermediate events; and these being also fixed, he goes on to the less remarkable ones in the *Greek* history. And the chronology of the *Greeks* being rectified, he makes use of it to rectify the cotemporary affairs of the *Egyptians*, *Assyrians*, *Babylonians*, *Medes*, and *Persians*, making use of the preceding step every where, for the determination of the subsequent one. He does also, in many cases, cast light and evidence back from the subsequent ones upon the precedent. But the other is his own order of proof, and ought to be that in which those who call his chronology in question should proceed to inquire into it.

The fourth and last method is that used by decyphers, in investigating words written in unknown characters, or in known ones substituted for one another, according to secret and complex laws. The particular methods by which this is done are only known to those who study and practice this art: however, it is manifest in general, that it is an algebra of its own kind; and that it bears a great resemblance to the three foregoing methods; also, that it may be said with justness and propriety in general, that philosophy is the art of decyphering the mysteries of nature; that criticism bears an obvious relation to decyphering; and that every theory which can explain all the phænomena, has all the same evidence in its favour, that it is possible the key of a cypher can have from its explaining that cypher. And if the cause assigned by the theory have also its real existence proved, it may be compared to the explanation of a cypher; which may be verified by the evidence of the person who writes in that cypher.

These speculations may seem uncouth to those who are not conversant in mathematical inquiries; but to me they appear to cast light and evidence upon the methods of pursuing knowledge in other matters, to

sharpen

sharpen the natural sagacity, and to furnish *Loci* for invention. It appears also not impossible, that future generations should put all kinds of evidences and inquiries into mathematical forms; and, as it were, reduce *Aristotle's* ten Categories, and bishop *Wilkins's* forty *Summa Genera*, to the head of quantity alone, so as to make mathematics and logic, natural history, and civil history, natural philosophy, and philosophy of all other kinds, coincide *omni ex parte*.

I will add two more remarks relating to the present subject.

First, then, As in many mechanical problems, which fall strictly under the consideration of mathematicians, the quantities considered depend on several others, so as to increase in the simple or compound, direct or inverse ratio of several others, and not to be greatest or least, when one or two of these are so, but when the *factum* of the proper powers of all is so; so throughout natural philosophy, in physic, in the analysis of the mind, &c. it is necessary to inquire as carefully as we can, upon how many considerable causes each effect depends; also, whether the ratios be simple or compound, direct or inverse. For though it will seldom happen, that one can bring the practical problems, that occur in real life, to an exact estimate in this way, yet one may avoid part of that uncertainty and confusion, to which persons who take things merely in the gross, are liable. Or in other words, it is better in every thing to have probable or tolerable limits for the *data*, with a regular method of computation, or even an approximation thereto, than to have only such gross and general conceptions, as result from the more or less frequent recurrency of impressions; even though they be somewhat improved by natural or acquired sagacity, arising, in a kind of implicit indefinite way, from experience.

Secondly,

Secondly, It seems to me, that the rays of light may be considered as a kind of fluxions in respect of the biggest component particles of matter; I mean those upon which Sir *Isaac Newton* supposes the colours of natural bodies, and the changes effected in chemical processes, to depend. For, as the increments of variable quantities, when diminished so as to bear no finite ratio to the quantities of which they are the increments, shew in a simple way the velocities with which these quantities are increased; and so give rise to the determination of fluxions from fluents, and fluents from fluxions, and to all the applications of these determinations to real quantities, all which is entirely grounded upon the supposition, that the fluxions are not increments, but relative nothings; so, since the rays of light are so small in respect of the biggest component particles, as to be relatively and practically nothing in respect of them, to bear no relation to any of them, all the differences observable in the actions of light upon these particles, and of these particles upon light, will depend purely upon the differences of these particles in respect of one another; it not being possible, that any part of them should arise from the comparative magnitude of light, which is equally nothing in respect of them all. And thus it seems, that optics and chemistry will, at last, become a master-key for unlocking the mysteries in the constitution of natural bodies, according to the method recommended by Sir *Isaac Newton*.

Let A , B , C , be three particles, whose magnitudes are 3, 2, and 1, respectively. It is evident, that the mutual influences between A and C , B and C , cannot correspond entirely to the ratio which A and B bear to each other, because C bears a different ratio to A from that which it bears to B ; and this difference of ratios must have its share in the effects of

of *A* and *B* upon *C*: whereas had *C* been a particle of light, it would have been equally nothing in respect both of *A* and *B*; and so the mutual influences between *A* and *C*, *B* and *C*, would entirely correspond to the difference between *A* and *B*, and decypher it. Thus the particles of light, by being infinitely smaller than the biggest component ones of natural bodies, may become a kind of *communis norma*, whereby to measure their active powers.

P R O P. LXXXVIII.

To make a general Application of the Theory of this and the foregoing Section, to the several Branches of Science.

ALL the sciences, knowledge of all kinds, may be reduced to the seven general heads following, when they are understood in the latitude here expressed.

First, Philology, or the knowledge of words, and their significations. It comprehends under it the arts of grammar and criticism. Rhetoric and poetry may be referred to it.

Secondly, Mathematics, or the doctrine of quantity. It may be divided into three branches, viz. Arithmetic, which makes use of numbers as the exponents of quantity; geometry, which uses figures for the same purpose; and algebra, which comprehends both these, and whose symbols are accordingly so general, as to represent the symbols of the two foregoing parts.

Thirdly, Logic, or the art of using words, considered as symbols, for making discoveries in all the branches of knowledge. It presupposes philology to a certain degree; and must evidently, in the view here given of it, receive great illustration from mathematics.

thematics, which is the art of making discoveries in the single category of quantity, by means of the simplest kind of symbols.

Fourthly, Natural history, or regular and well-digested accounts of the phænomena of the natural world. It may be distributed into six parts, *i. e.* into the natural histories of animals, plants, minerals, the earth considered as a terraqueous globe, the atmosphere, and the heavenly bodies.

Fifthly, Civil history, or regular accounts of the transactions of the world politic. To this head must be referred that part of geography which treats of the present manners, customs, laws, religion, &c. of the several nations of the world.

Sixthly, Natural philosophy, or the application of the arts of mathematics and logic to the phænomena of natural and civil history, communicated to us by means of our previous skill in philology, in order to decypher the laws by which the external world is governed, and thereby to predict or produce such phænomena, as we are interested in. Its parts are mechanics, hydrostatics, pneumatics, optics, astronomy, chemistry, the theories of the several manual arts and trades, medicine and psychology, or the theory of the human mind, with that of the intellectual principles of brute animals.

Seventhly, Religion, which might also be called divine philosophy. This requires the application of all the foregoing branches of knowledge to each other in an endless reciprocation, in order to discover the nature of the invisible world, of God, of good and evil spirits, and of the future state, which commences at death, with all the duties that result from these considerations. The arts of ethics and politics are to be referred to this head. For, though these arts are supposed to teach individuals, and bodies politic, how to arrive at their *summum bonum* in the present world, yet, since the rules given for this purpose

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either are or ought to be the same with those which teach mankind how to secure a happy futurity, it is plain, that these arts are included within the precepts of religion.

All these branches of knowledge are very much involved in each other; so that it is impossible to make any considerable progress in any one, without the assistance of most or all the rest. However, each has also an independent part, which being laid down as a foundation, we may proceed to improve it by the light afforded from the independent parts of the other branches. I will here subjoin a few hints concerning the proper manner of proceeding in each branch.

OF PHILOLOGY.

The rudiments of the native language are learnt in infancy, by the repeated impressions of the sounds, at the same time that the things signified are presented to the senses, as has been already explained. Words standing for intellectual things, particles, &c. are decyphered by their connection with other words, by their making parts of sentences, whose whole import is known. Grammatical analogy and derivation do also, in many cases, discover the import of words. And many words may be explained by definitions. Where these several ways concur, the sense is soon learnt, and steadily fixed; where they oppose each other, confusion arises for a time, but the strongest authority prevails at last. Translations and dictionaries explain the words of unknown languages by those of known ones. Afterwards we decypher by the context, deduce the sense from analogy, &c. These last methods reflect authority upon the translations and dictionaries, where they agree with them. In living languages the import of the principal words may be ascertained with ease and certainty; and these being fixed, the rest become determinable

and decypherable by proper care and caution, so that no practical errors can remain. In dead languages the difficulty is greater; but the certainty that ultimately results, is not less practically in respect of the bulk of the language, on account of the number of coincidences. But much remains undone yet, particularly in respect of the *Hebrew* language. Logic, natural and civil history, philosophical and religious knowledge, may all, in their several ways, contribute to fix the true sense of words. And the fixing the senses of words, by all the methods here enumerated, may be called the art of making dictionaries. It receives great assistance from the art of grammar; and is at the same time the main foundation of it. This last art has also the same connections with the other branches of knowledge; as that of fixing the senses of words. The same may be said of criticism; which may be defined the art of restoring the corrupted passages of authors, and ascertaining their genuine sense, and method of reasoning.

In all these things there seems to be a sufficient foundation for unity of opinion amongst those that are truly learned and candid; at least in all important points. And, in fact, the differences here amongst the *literati* are plainly owing, in great measure, to ambition, envy, affectation of singularity and novelty, &c. All these things magnify the ideas and coalescences, which a man calls his own, those of his party, &c. associate ideas of truth, excellence, genius, &c. to them, and opposite ones to all that the supposed adversary delivers.

No sceptic can proceed so far as to disclaim the sense of the words of his native tongue, or of a foreign one, which he understands. The things signified thereby must and will be suggested by, and coalesce with, the sounds; so that he cannot but understand what he hears and reads. And this is all the

truth

truth that belongs to philology as such. The truth of the things expressed in words is a consideration belonging to the several other branches of knowledge respectively.

As the plain didactic style is intended merely to inform the understanding, so the rhetorical and poetical styles are intended to excite the passions by the associations, which figurative terms and forms of expression, flowing periods, numbers, rhymes, similes, fables, fictions, &c. draw after them.

Painting and music produce a like effect upon the passions as rhetoric and poetry, and by means that are not very unlike. But I shall have occasion hereafter to say something more concerning all these imaginative arts.

OF MATHEMATICS.

Mathematics are that branch of knowledge which is the most independent of any, and the least liable to uncertainty, difference of opinion, and sceptical doubts. However, uncertainties, differences, and doubts, have arisen here; but then they have been chiefly about such parts of mathematics as fall under the consideration of the logician. For, it seems impossible that a man who has qualified himself duly, should doubt about the justness of an arithmetical, algebraical, or fluxional operation, or the conclusiveness of a geometrical demonstration.

The words point, line, surface, infinitely great, infinitely little, are all capable of definitions, at least of being explained by other words. But then these words cannot suggest any visible ideas to the imagination, but what are inconsistent with the very words themselves. However, this inconsistency has no effect upon the reasoning. It is evident, that all that can be meant by the three angles of a triangle being equal to two right ones, or the parabolic area to $\frac{2}{3}$ of the circumscribing parallelogram,

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or deduced from these positions, must always hold in future fact; and this, as observed above, is all the truth that any thing can have. In fluxional conclusions it is demonstratively evident, that the quantity under consideration cannot be greater or less by any thing assignable, than according to the fluxional conclusion; and this seems to me entirely the same thing as proving it to be equal.

I cannot presume to suggest any particular methods by which farther discoveries may be made in mathematical matters, which are so far advanced, that few persons are able to comprehend even what is discovered and unfolded already. However, it may not be amiss to observe, that all the operations of arithmetic, geometry, and algebra, should be applied to each other in every possible way, so as to find out in each something analogous to what is already known and established in the other two. The application of the arithmetical operations of division and extraction of roots to algebraic quantities, and of the method of obtaining the roots of numeral equations by approximation to specious ones, as taught by Sir *Isaac Newton*, have been the sources of the greatest fluxional discoveries.

OF LOGIC.

It is the purport of this and the foregoing section, to give imperfect rudiments of such an art of logic, as is defined above, *i. e.*, as should make use of words in the way of mathematical symbols, and proceed by mathematical methods of investigation and computation in inquiries of all sorts. Not that the *data* in the sciences are as yet, in general, ripe for such methods; but they seem to tend to this more and more perpetually, in particular branches, so that it cannot be amiss to prepare ourselves, in some measure, previously.

Logic,

Logic, and metaphysics, which are nearly allied to logic, seem more involved in obscurity and perplexity, than any other part of science. This has probably been the chief source of scepticism, since it appears necessary, that that part of knowledge, which is the basis of all others, which is to shew wherein certainty, probability, possibility, improbability, and impossibility, consist, should itself be free from all doubt and uncertainty.

It seems also, that as logic is required for the basis of the other sciences, so a logic of a second order is required for a basis to that of the first, of a third for that of the second, and so on *sine limite*: which, if it were true, would, from the nature of dependent evidences, prove that logic is either absolutely certain, or absolutely void of all probability. For, if the evidence for it be ever so little inferior to unity, it will, by the continual infinite multiplication required in dependent evidences infinitely continued, bring itself down to nothing. Therefore, *e converso*, since no one can say, that the rules of logic are void of all probability, the *summum genus* of them must be certain. This *summum genus* is the necessary coalescence of the subject with the predicate. But the argument here alleged is merely one *ad hominem*, and not the natural way of treating the subject. The necessary coalescence just spoken of carries its own evidence with it. It is necessary from the nature of the brain, and that in the most confirmed sceptic, as well as in any other person. And we need only inquire into the history of the brain, and the physiological influences of words and symbols upon it by association, in order to see this. I am also inclined to believe, that the method here proposed of considering words and sentences as impressions, whose influence upon the mind is entirely to be determined by the associations heaped upon them in the intercourse of life, and endeavouring to determine these associations,

both analytically and synthetically, will cast much light upon logical subjects, and cut off the sources of many doubts and differences.

As the theories of all other arts and sciences must be extracted from them, so logic, which contains the theory of all these theories, must be extracted from these theories; and yet this is not to reason in a circle in either case, since the theory is first extracted from self-evident or allowed particulars, and then applied to particulars not yet known, in order to discover and prove them.

It may not be amiss here to take notice how far the theory of these papers has led me to differ, in respect of logic, from Mr. *Locke's* excellent *Essay on Human Understanding*, to which the world are so much indebted for removing prejudices and incumbrances, and advancing real and useful knowledge.

First, then, It appears to me, that all the most complex ideas arise from sensation; and that reflection is not a distinct source, as Mr. *Locke* makes it.

Secondly, Mr. *Locke* ascribes ideas to many words, which, as I have defined idea, cannot be said to have any immediate and precise ones; but only to admit of definitions. However, let definition be substituted instead of idea, in these cases, and then all Mr. *Locke's* excellent rules concerning words, delivered in his third book, will suit the theory of these papers.

As to the first difference, which I think may be called an error in Mr. *Locke*, it is, however, of little consequence. We may conceive, that he called such ideas as he could analyse up to sensation, ideas of sensation; the rest ideas of reflection, using reflection as a term of art, denoting an unknown quantity. Besides which it may be remarked, that the words which, according to him, stand for ideas of reflection, are, in general words, that, according to the theory of these papers, have no ideas, but
defi-

definitions only. And thus the first difference, is as it were, taken away by the second; for, if these words have no immediate ideas, there will be no occasion to have recourse to reflection as a source of ideas; and, upon the whole, there is no material repugnancy between the consequences of this theory, and any thing advanced by Mr. *Locke*.

The ingenious bishop *Berkeley* has justly observed against Mr. *Locke*, that there can be no such thing as abstract ideas, in the proper sense of the word idea. However, this does not seem to vitiate any considerable part of Mr. *Locke's* reasoning. Substitute definition for idea in the proper places, and his conclusions will hold good in general.

OF NATURAL HISTORY.

Natural history is a branch of knowledge, which, at the first view, appears to have a boundless extent, and to be capable of the utmost practical precision and certainty, if sufficient care and industry be employed. And, in fact, the doubts and differences here are not very considerable; they do also grow less and less every day, by the great quantity of knowledge of this kind, which is poured in from all quarters, as learning and inquisitiveness diffuse themselves more and more amongst all nations, and all orders of men.

The materials for natural history, which any single person can collect from his own observation, being very inconsiderable, in respect of those which he wants, he is obliged to have recourse to others; and therefore must depend upon their testimony, just as in civil history. And our assent in each case, being excited by a variety of concurrent proofs, and of coincident circumstances, transfers part of its authority upon the other. We believe testimony in natural history, because

cause we do in civil, and *vice versa* ; and have a variety of concurrent confirmations in both cases.

However, as the general facts are thus practically certain, so the subordinate ones are, in many cases, liable to doubts. And it is evident, that, for the resolution of these doubts in natural history, we must borrow the assistance of all the other branches of science ; and that some skill in philology must be attained, before we can hope to arrive at any tolerable perfection in natural or civil history. Natural history is the only sure basis of natural philosophy, and has some influence upon all the other sciences.

OF CIVIL HISTORY.

The general evidences upon which civil history is grounded, have been just hinted at. It is manifest, that the discoveries of natural historians, astronomers, linguists, antiquaries, and philosophers of all kinds, have brought great light and evidence upon this branch of knowledge within the last two centuries ; and are likely to do so more and more.

The ancient history of the kingdoms of *Asia Minor*, *Egypt*, and *Greece*, will probably be much better understood, when the inhabitants of those countries become learned.

He that would search into the first ages of the world must take the scriptures for his guide, lay down the truth of these as unquestionable, and force all other evidences into that position. This seems to have been the method taken by Sir *Isaac Newton* in his *Chronology*, and which at last unfolded to him the proper method of detecting and correcting the mistakes in the ancient technical chronology of the *Greeks* by itself.

The concurrent independent evidences in the grand points of history are so much more numerous than the

the dependent ones, and most of them so strong, singly taken, that the deficiency from certainty in these grand points cannot be distinguished by the human mind. And therefore it is a practical error of great importance to suppose, that such kind of historical evidences are inferior to mathematical ones. They are equal, as far as we have any thing to do with them, *i. e.* can judge of them, or be influenced by them. All future facts depending on them have as good a basis, as those depending on mathematical evidences. I speak here of principal matters, such as the conquests of *Alexander* and *Julius Cæsar*, and the main history, common and miraculous, of the Old and New Testaments. Till our knowledge be applied to the predicting or producing future facts, no sort of it is of use or importance to us; and the application of mathematical knowledge is just as much exposed to the several kinds and degrees of uncertainty, as that of any other. That the evidence for principal historical facts is not, in general, considered as equal to mathematical certainty, arises partly from the just-mentioned ill-grounded affirmations of learned men; partly from the complexness of the historical proofs, which require time and consideration to digest them; and partly because the uncertainty attending subordinate facts has diluted the evidence of the principal and unquestionable ones, since the same general forms of expression are, and must be, used in both cases.

OF NATURAL PHILOSOPHY.

It may be observed of natural philosophy, that in the parts where the ideas are simple, clear, and of the visible kind, or adequately expounded by such, and the method of investigation and computation mathematical, as in mechanics, hydrostatics, pneumatics, optics, and astronomy, the doubts and diversities

versities of opinion which arise, are inconsiderable. But in the theories of chemistry, of manual arts and trades, of medicine, and, in general, of the powers and mutual actions of the small parts of matter, the uncertainties and perplexities are as great, as in any part of science. For the small parts of matter, with their actions, are too minute to be the objects of sight; and we are as yet neither possessed of a detail of the phenomena sufficiently copious and regular, whereon to ground an investigation; nor of a method of investigation subtle enough to arrive at the subtlety of nature, even in the biggest component particles, much less in the particles of the smaller orders; and how far the number of orders may go, is impossible to say. I see no contradiction in supposing it infinite, and a great difficulty in stopping at any particular size.

Suppose the number of orders of particles infinite, or at least very great; and that particles of all orders are perpetually flying off from all bodies with great velocity. First, This may occasion the gravitation of the great bodies of the universe to each other, by the impulse of the smaller corpuscles upon particles of sizes equal to each other in the greater bodies, the impulses of the larger corpuscles, and upon particles, of unequal size, being evanescent in respect of the foregoing impulses. But where particles approach near to one another, and the corpuscles bear some finite ratio to the particles, so as not to pervade them freely, before they come to particles of equal size to each other, but affect them in proportion to their surfaces, not solid content, and I suppose from many other causes, attractions of other kinds may arise: and if one or both of the contiguous particles send out many corpuscles with great force; also, if these corpuscles effervesce together in the intermediate space, and gain new forces thence, &c. repulsive powers may rise. If it be reasonable to suppose many orders

of particles, it is also reasonable to suppose, that their powers and properties are somewhat analogous to one another; and that those of the larger particles arise from, and are compounded of, those of the next less in size, and so on; just as the whole gravity of the moon is compounded of the gravity of all its parts. But these are all very gross and uncertain conjectures.

In the mean time, it seems proper to use the words magnetism, electricity, attraction of cohesion, *spiritus rector*, acrimony of the animal juices, &c. as terms of art, as unknown causes of known effects. But then they ought always to be defined, the definitions rigorously kept to, and all secondary ideas from prior associations excluded. Were this done in chemistry and medicine, it would produce a great reformation, and at once cut off many incumbrances, perplexities, and obscurities. The *vis inertiae* of bodies, and the equivalent terms, were once terms of this kind, standing for the unknown cause of known phenomena. By degrees these phenomena were digested into order, the terms contributing thereto, and the three several kinds of them, classed respectively under the three laws of nature, which have been applied synthetically since, and given rise to the greatest mechanical discoveries. The same may be observed of gravity. And if the laws of magnetism, electricity, and the attraction of cohesion, could be ascertained in the same manner as the laws of the *vis inertiae* and gravity, we should be enabled to predict and produce many effects of great importance to us.

It is of the highest use to us in practical matters, that the properties of bodies are so closely connected with each other. Thus the colour and specific gravity of a metal, the visible idea of a plant, also its taste or smell, give us a practical certainty in respect of all the other properties. This close connection of
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the properties follows undoubtedly from the powers and mutual actions of the small parts; so that, if we could arrive at the knowledge of these last, we should immediately see not only the reason of all the properties of bodies, which are known at present, but be able to discover innumerable other relative ones. In the mean time we must endeavour to discover, digest, and register, the various properties of natural bodies, as they rise to view from suitable experiments; and thus prepare the way for those who shall hereafter decypher their internal constitution.

OF RELIGION.

All the foregoing branches of knowledge ought to be considered as mere preparatories and preliminaries to the knowledge of religion, natural and revealed. They all, in their several orders and degrees, concur to establish the principal doctrines and duties of it; and these, when established, become the best means for attaining knowledge. The benevolence of the Deity, and the doctrine of final causes, are the best clue for guiding us through the labyrinths of natural phænomena, and particularly of those which relate to animals. The scriptures are the only book which can give us any just idea of ancient times, of the original of mankind, their dispersion, &c. or of what will befall them in future generations. As to future things, predicted in the scriptures, we can as yet collect nothing more than general intimations; but there is reason to believe, that succeeding generations may arrive at a far more precise interpretation of prophecy. It may also be, that much philosophical knowledge is concealed in the scriptures; and that it will be revealed in its due time. The analogy between the word and works of God, which is a consideration of the religious kind, seems to comprehend the
most

most important truths. To all this it must be added, that the temper of mind prescribed by religion, viz. modesty, impartiality, sobriety, and diligence, are the best qualifications for succeeding in all inquiries. Thus religion comprehends, as it were, all other knowledge, advances, and is advanced by all; at the same time that where there is a morally good disposition, a very small portion of other knowledge is sufficient for the attainment of all that is necessary for virtue and comfort here, and eternal happiness hereafter.

The great differences of opinion, and contentions which happen in religious matters, are plainly owing to the violence of men's passions, more than to any other cause. Where religion has its due effect in restraining these, and begetting true candour, we may expect a unity of opinion, both in religious and other matters, as far as is necessary for useful practical purposes.

S E C T. III.

OF THE AFFECTIONS IN GENERAL.

P R O P. LXXXIX.

To explain the Origin and Nature of the Passions in general.

HERE we may observe,

First, That our passions or affections can be no more than aggregates of simple ideas united by association. For they are excited by objects, and by the incidents of life. But these, if we except the impressed sensations, can have no power of affecting us, but what they derive from association; just as was observed above of words and sentences.

Secondly, Since therefore the passions are states of considerable pleasure or pain, they must be aggregates of the ideas, or traces of the sensible pleasures and pains, which ideas make up by their number, and mutual influence upon one another, for the faintness and transitory nature of each singly taken. This may be called a proof *a priori*. The proof *a posteriori* will be given, when I come to analyse the six classes of intellectual affections, viz. imagination, ambition, self-interest, sympathy, theopathy, and the moral sense.

Thirdly, As sensation is the common foundation of all these, so each in its turn, when sufficiently generated, contributes to generate and model all the rest. We may conceive this to be done in the following manner. Let sensation generate imagination; then will sensation and imagination together generate ambition; sensation, imagination, and ambition, self-

self-interest; sensation, imagination, ambition, and self-interest, sympathy; sensation, imagination, ambition, self-interest, and sympathy, theopathy; sensation, imagination, ambition, self-interest, sympathy, and theopathy, the moral sense: and, in an inverted order, imagination will new-model sensation; ambition, sensation and imagination; self-interest, sensation, imagination, and ambition; sympathy, sensation, imagination, ambition, and self-interest; theopathy, sensation, imagination, ambition, self-interest, and sympathy; and the moral sense, sensation, imagination, ambition, self-interest, sympathy, and theopathy: till at last, by the numerous reciprocal influences of all these upon each other, the passions arrive at that degree of complexity, which is observed in fact, and which makes them so difficult to be analysed.

Fourthly, As all the passions arise thus from pleasure and pain, their first and most general distribution may be into the two classes of love and hatred, *i. e.* we may term all those affections of the pleasurable kind, which objects and incidents raise in us, love; all those of the painful kind, hatred. Thus we are said to love not only intelligent agents of morally good dispositions, but also sensual pleasures, riches, and honours; and to hate poverty, disgrace, and pain, bodily and mental.

Fifthly, When our love and hatred are excited to a certain degree, they put us upon a variety of actions, and may be termed desire and aversion; by which last word I understand an active hatred. Now the actions which flow from desire and aversion, are entirely the result of associated powers and circumstances, agreeably to the twentieth, twenty-first, and twenty-second propositions, with their corollaries. The young child learns to grasp, and go up to the anything that pleases him, and to withdraw his hand from the fire that burns him, at first from the mechanism

chanism of his nature, and without any deliberate purpose of obtaining pleasure, and avoiding pain, or any explicit reasoning about them. By degrees he learns, partly from the recurrency of these mechanical tendencies, inspired by God, as one may say, by means of the nature which he has given us; and partly from the instruction and imitation of others; to pursue every thing which he loves and desires; fly from every thing which he hates; and to reason about the method of doing this, just as he does upon other matters. And, because mankind are for the most part pursuing or avoiding something or other, the desire of happiness, and the aversion to misery, are supposed to be inseparable from, and essential to, all intelligent natures. But this does not seem to be an exact or correct way of speaking. The most general of our desires and aversions are factitious, *i. e.* generated by association; and therefore admit of intervals, augmentations, and diminutions. And, whoever will be sufficiently attentive to the workings of his own mind, and the actions resulting therefrom, or to the actions of others, and the affections which may be supposed to occasion them, will find such differences and singularities in different persons, and in the same person at different times, as no way agree to the notion of an essential, original, perpetual desire of happiness, and endeavour to attain it; but much rather to the factitious associated desires and endeavours here asserted. And a due regard to this will, as it seems to me, solve many difficulties and perplexities found in treatises upon the passions. The writers upon this subject have begun in the synthetical method prematurely, and without having premised the analytical one. For it is very true, that, after general desires and endeavours are generated, they give rise in their turn to a variety of particular ones. But the original source is in the particular ones, and the general ones never alter and new-model the particular ones so much,

much, as that there are not many traces and vestiges of their original mechanical nature and proportions remaining.

Sixthly, The will appears to be nothing but a desire or aversion sufficiently strong to produce an action that is not automatic primarily or secondarily. At least it appears to me, that the substitution of these words for the word *will* may be justified by the common usage of language. The will is therefore that desire or aversion, which is strongest for the then present time. For if any other desire was stronger, the muscular motion connected with it by association would take place, and not that which proceeds from the will, or the voluntary one, which is contrary to the supposition. Since therefore all love and hatred, all desire and aversion, are factitious, and generated by association, *i. e.* mechanically; it follows that the will is mechanical also.

Seventhly, Since the things which we pursue do, when obtained, generally afford pleasure, and those which we fly from affect us with pain, if they overtake us, it follows that the gratification of the will is generally attended or associated with pleasure, the disappointment of it with pain. Hence a mere associated pleasure is transferred upon the gratification of the will; a mere associated pain upon the disappointment of it. And if the will was always gratified, this mere associated pleasure would, according to the present frame of our natures, absorb, as it were, all our other pleasures; and thus by drying up the source from whence it sprung, be itself dried up at last: and the first disappointments, after a long course of gratification, would be intolerable. Both which things are sufficiently observable, in an inferior degree, in children that are much indulged, and in adults, after a series of successful events. Gratifications of the will without the consequent expected pleasure, and disappointments of it without the consequent expected

pain, are particularly useful to us here. And it is by this, amongst other means, that the human will is brought to a conformity with the divine; which is the only radical cure for all our evils and disappointments, and the only earnest and medium for obtaining lasting happiness.

Eighthly, We often desire and pursue things which give pain rather than pleasure. Here it is to be supposed, that at first they afforded pleasure, and that they now give pain on account of a change in our nature and circumstances. Now, as the continuance to desire and pursue such objects, notwithstanding the pain arising from them, is the effect of the power of association, so the same power will at last reverse its own steps, and free us from such hurtful desires and pursuits. The recurrency of pain will at last render the object undesirable and hateful. And the experience of this painful process, in a few particular instances, will at last, as in other cases of the same kind, beget a habit of ceasing to pursue things, which we perceive by a few trials, or by rational arguments, to be hurtful to us upon the whole.

Ninthly, A state of desire ought to be pleasant at first from the near relation of desire to love, and of love to pleasure and happiness. But in the course of a long pursuit, so many fears and disappointments, apparent or real, in respect of the subordinate means, and so many strong agitations of mind passing the limits of pleasure, intervene, as greatly to chequer a state of desire with misery. For the same reasons states of aversion are chequered with hope and comfort.

Tenthly, Hope and fear are, as just now observed, the attendants upon desire and aversion. These affect us more or less, according to the more or less frequent recurrency of the pleasing and painful ideas, according to the greater or less probability of the expected event, according to the greater or less distance
of

of time, &c. the power of association displaying itself every where in the agitations of mind excited by these passions. It is particularly remarkable here, that our hopes and fears rise and fall with certain bodily dispositions, according as these favour or oppose them.

Eleventhly, Joy and grief take place when the desire and aversion, hope and fear, are at an end; and are love and hatred, exerted towards an object which is present, either in a sensible manner, or in a rational one, *i. e.* so as to occupy the whole powers of the mind, as sensible objects, when present, and attended to, do the external senses. It is very evident, that the objects of the intellectual pleasures and pains derive their power of thus affecting the mind from association.

Twelfthly, After the actual joy and grief are over, and the object withdrawn, there generally remains a pleasing or displeasing recollection or resentment, which recurs with every recurrency of the idea of the object, or of the associated ones. This recollection keeps up the love or hatred. In like manner the five grateful passions, love, desire, hope, joy, and pleasing recollection, all enhance one another; as do the five ungrateful ones, hatred, aversion, fear, grief, and displeasing recollection. And the whole ten, taken together, comprehend, as appears to me, all the general passions of human nature.

S E C T. IV.

O F M E M O R Y.

P R O P X C.

To examine how far the Phænomena of Memory are agreeable to the foregoing Theory.

MEMORY was defined in the introduction to be that faculty by which traces of sensations and ideas recur, or are recalled, in the same order and proportion, accurately or nearly, as they were once presented.

Now here we may observe,

First, That memory depends entirely or chiefly on the state of the brain. For diseases, concussions of the brain, spirituous liquors, and some poisons, impair or destroy it; and it generally returns again with the return of health, from the use of proper medicines and methods. And all this is peculiarly suitable to the notion of vibrations. If sensations and ideas arise from peculiar vibrations, and dispositions to vibrate, in the medullary substance of the brain, it is easy to conceive, that the causes above alleged may so confound the sensations and ideas, as that the usual order and proportion of the ideas shall be destroyed.

Secondly, The rudiments of memory are laid in the perpetual recurrency of the same impressions, and clusters of impressions. How these leave traces, in which the order is preserved, may be understood from the eighth, ninth, tenth, and eleventh propositions. The traces which letters, and words, *i. e.* clusters of letters, leave, afford an instance and example of this. And, as in languages the letters are fewer than the syllables, the syllables than the words, and the words

than

than the sentences, so the single sensible impressions, and the small clusters of them, are comparatively few in respect of the large clusters; and, being so, they must recur more frequently, so as the sooner to beget those traces which I call the rudiments or elements of memory. When these traces or ideas begin to recur frequently, this also contributes to fix them, and their order, in the memory, in the same manner as the frequent impression of the objects themselves.

Thirdly, Suppose now a person so far advanced in life, as that he has learnt all these rudiments, *i. e.* that he has ideas of the common appearances and occurrences of life, under a considerable variety of subordinate circumstances, which recur to his imagination from the slightest causes, and with the most perfect facility; and let us ask, how he can be able to remember or recollect a past fact, consisting of one thousand single particulars, or of one hundred such clusters as are called the rudiments of memory; ten single particulars being supposed to constitute a rudiment? First, then, we may observe, that there are only one hundred links wanting in the chain; for he has already learnt considerable exactness in the subordinate circumstances of the one hundred clusters; and perfect exactness is not to be supposed or required.—Secondly, The one hundred clusters recur again and again to the imagination for some time after the fact, in a quick and transient manner, as those who attend sufficiently to what passes in their own minds may perceive; and this both makes the impression a little deeper, and also serves to preserve the order. If the person attempts to recollect soon after the impression, the effect remaining in the brain is sufficient to enable him to do this with the accuracy required and experienced; if a longer time intervenes, before he attempts to recollect, still the number of involuntary recurrences makes up in some measure for the want of this voluntary recollection. However, the power of recollection declines in general, and is

entirely lost by degrees. It confirms this reasoning, that a new set of strong impressions destroys the power of recollection. For this must both obliterate the effects of the foregoing impressions, and prevent the recurrency of the ideas.—Thirdly, As the single impressions, which make the small clusters, are not combined together at hazard, but according to a general tenor in nature, so the clusters which make facts succeed each other according to some general tenor likewise. Now this both lessens the number of varieties, and shews that the association between many of the clusters, or rudiments, or one hundred links supposed to be wanting, is cemented already. This may be both illustrated and exemplified by the observation, that it is difficult to remember even well-known words that have no connection with each other, and more so to remember collections of barbarous terms; whereas adepts in any science remember the things of that science with a surprizing exactness and facility.—Fourthly, Some clusters are excluded from succeeding others, by ideas of inconsistency, impossibility, and by the methods of reasoning, of which we become masters as we advance in life.—Fifthly, The visible impressions which concur in the past fact, by being vivid, and preserving the order of place, often contribute greatly to preserve the order of time, and to suggest the clusters which may be wanting.—Sixthly, It is to be observed, that we think in words both the impressions and the recurrences of ideas will be attended with words; and these words, from the great use and familiarity of language, will fix themselves strongly in the fancy, and by so doing bring up the associated trains of ideas in the proper order, accurately or nearly. And thus, when a person relates a past fact, the ideas do in some cases suggest the words, whilst in others the words suggest the ideas. Hence illiterate persons do not remember nearly so well as others, *ceteris paribus*. And
I suppose

I suppose the same is true of deaf persons in a still greater degree. But it arises hence also, that many mistakes in the subordinate circumstances are committed in the relations of past facts, if the relater descends to minute particulars. For the same reasons these mistakes will be so associated with the true facts after a few relations, that the relater himself shall believe, that he remembers them distinctly.—Seventhly, The mistakes which are committed both on the foregoing account and others, make considerable abatements in the difficulty here to be solved.

Fourthly, Let it now be asked, in what the recollection of a past fact, consisting of one hundred clusters, as above, differs from the transit of the same one hundred clusters over the fancy, in the way of a reverie? I answer, partly in the vividness of the clusters, partly and principally in the readiness and strength of the associations, by which they are cemented together. This follows from what has been already delivered; but it may be confirmed also by many other observations.—Thus, first many persons are known by relating the same false story over and over again, *i. e.* by magnifying the ideas, and their associations, at last to believe that they remember it. It makes as vivid an impression upon them, and hangs as closely together, as an assemblage of past facts recollected by memory.—Secondly, All men are sometimes at a loss to know whether clusters of ideas that strike the fancy strongly, and succeed each other readily and immediately, be recollections, or mere reveries. And the more they agitate the matter in the mind, the more does the reverie appear like a recollection. It resembles this, that if in endeavouring to recollect a verse, a wrong word, suiting the place, first occurs, and afterwards the right one, it is difficult during the then present agitation to distinguish the right one. But afterwards, when this agitation is subsided, the right word easily regains its place. Persons of irritable

table nervous systems are more subject to such fallacies than others. And madmen often impose upon themselves in this way, viz. from the vividness of their ideas and associations, produced by bodily causes. The same thing often happens in dreams. The vividness of the new scene often makes it appear like one that we remember, and are well acquainted with. Thirdly, If the specific nature of memory consist in the great vigour of the ideas, and their associations, then, as this vigour abates, it ought to suggest to us a length of time elapsed; and *vice versa*, if it be kept up, the distance of time ought to appear contracted. Now this last is the case: for the death of a friend, or any interesting event, often recollected and related, appears to have happened but yesterday, as we term it, viz. on account of the vividness of the clusters, and their associations, corresponding to the nature of a recent event. — Fourthly, It is not, however, to be here supposed, that we have not many other ways of distinguishing real recollections from mere reveries. For the first are supported by their connection with known and allowed facts, by various methods of reasoning, and having been related as real recollections, &c.

Fifthly, In like manner we distinguish a new place, book, person, &c. from one which we remember, supposing both to be presented in like circumstances. The parts, associates, &c. of that which we remember, strike us more strongly, are suggested by each other, and hang together, which does not hold of the new. The old does also suggest many associates, which a new one in like circumstances would not. And if from the then state of fancy, the distance of time, &c. there be any doubt of these things, either with respect to the old or new, a like doubt arises in respect of the memory. An attentive person may observe, that he determines of such things, whether they be old or new, by the vividness of the ideas, and
their

their power of suggesting each other, and foreign associates.

Some persons seem to suppose, that the soul surveys one object, the old for instance, and comparing with the impressions which a familiar new one would excite, calls the old one an object remembered. But this is like supposing an eye within the eye to view the pictures made by objects upon the *retina*. Not to mention, that the soul cannot in the same instant, during the same *τὸ νῦν*, survey both the old and new, and compare them together; nor is there any evidence, that this is done in fact. A person who inquires into the nature of memory, may indeed endeavour to state the difference between the impressions of old and new, as I have done here; but this is a speculation that few persons concern themselves with, whereas all remember and apply the words relative to memory, just as they do other words. We may conclude therefore, that the difference of vividness and connection in the ideas, with the other associates of recollections, are a sufficient foundation for the proper use of the words relative to the memory, just as in other like cases.

Sixthly, The peculiar imperfection of the memory in children tallies with the foregoing account of this faculty; and indeed this account may be considered as a gross general history of the successive growth of the memory, in passing from childhood to adult age. Children must learn by degrees the ideas of single impressions, the clusters which I call rudiments, and the most usual connections and combinations of these. They have also the use of words, and of objects and incidents, as signs and symbols, with the proper method of reasoning upon them, to learn; and during their novitiate in these things their memories must labour under great imperfections. It appears also, that the imperfections peculiar to children correspond in kind as well as degree to the reasons

sons here assigned for them. Their not being able to digest past facts in order of time is, in great measure, owing to their not having the proper use of the symbols, whereby time is denoted.

Seventhly, The peculiar imperfection of the memory in aged persons tallies also with the foregoing account. The vibrations, and dispositions to vibrate, in the small medullary particles, and their associations, are all so fixed by the callosity of the medullary substance, and by repeated impressions and recurrences, that new impressions can scarce enter, that they recur seldom, and that the parts which do recur bring in old trains from established associations, instead of continuing those which were lately impressed. Hence one may almost predict what very old persons will say or do upon common occurrences. Which is also the case frequently with persons of strong passions, for reasons that are not very unlike. When old persons relate the incidents of their youth with great precision, it is rather owing to the memory of many preceding memories, recollections, and relations, than to the memory of the thing itself.

Eighthly, In recovering from concussions, and other disorders of the brain, it is usual for the patient to recover the power of remembering the then present common incidents for minutes, hours, and days, by degrees; also the power of recalling the events of his life preceding his illness. At length he recovers this last power perfectly, and at the same time forgets almost all that past in his illness, even those things which he remembered, at first, for a day or two. Now the reason of this I take to be, that upon a perfect recovery the brain recovers its natural state, *i. e.* all its former dispositions to vibrate; but that such as took place during the preternatural state of the brain, *i. e.* during his illness, are all obliterated by the return of the natural state. In like manner dreams, which happen in a peculiar state of the brain,

i. e. in

e. in sleep, vanish, as soon as vigilance, a different state, takes place. But if they be recollected immediately upon waking, and thus connected with the state of vigilance, they may be remembered. But I shall have occasion to be more explicit on this head in the next section.

Ninthly, It is very difficult to make any plausible conjectures why some persons of very weak judgments, not much below idiots, are endued with a peculiar extraordinary memory. This memory is generally the power of recollecting a large group of words, suppose, as those of a sermon, in a short time after they are heard, with wonderful exactness and readiness; but then the whole is obliterated, after a longer time, much more completely than in persons of common memories and judgments. One may perhaps conjecture, that the brain receives all dispositions to vibrate sooner in these persons, and lets them go sooner, than in others. And the last may contribute to the first: for, new impressions may take place more deeply and precisely, if there be few old ones to oppose them. The most perfect memory is that which can both receive most readily, and retain most durably. But we may suppose, that there are limits, beyond which these two different powers cannot consist with each other.

Tenthly, When a person desires to recollect a thing that has escaped him, suppose the name of a person, or visible object, he recalls the visible idea, or some other associate, again and again, by a voluntary power, the desire generally magnifying all the ideas and associations; and thus bringing in the association and idea wanted, at last. However, if the desire be great, it changes the state of the brain, and has an opposite effect; so that the desired idea does not recur, but all has subsided; perhaps not even then.

Eleventhly, All our voluntary powers are of the nature of memory; as may be easily seen from the foregoing

foregoing account of it, compared with the account of the voluntary powers given in the first chapter. And it agrees remarkably with this, that, in morbid affections of the memory, the voluntary actions suffer a like change and imperfection.

Twelfthly, For the same reasons the whole powers of the soul may be referred to the memory, when taken in a large sense. Hence, though some persons may have strong memories with weak judgments, yet no man can have a strong judgment with a weak original power of retaining and remembering.

S E C T. V.

OF IMAGINATION, REVERIES, AND DREAMS.

P R O P. XCI.

To examine how far the Phenomena of Imagination, Reveries, and Dreams, are agreeable to the foregoing Theory.

THE recurrence of ideas, especially visible and audible ones, in a vivid manner, but without any regard to the order observed in past facts, is ascribed to the power of imagination or fancy. Now here we may observe, that every succeeding thought is the result either of some new impression, or of an association with the preceding. And this is the common opinion. It is impossible indeed to attend so minutely to the succession of our ideas, as to distinguish and remember for a sufficient time the very impression or association which gave birth to each thought; but we can do this as far as it can be expected to be done, and in so great a variety of instances, that our argument for the prevalence of the foregoing principle of association in all instances, except those of new impressions, may be esteemed a complete induction.

A reverie differs from imagination only in that the person being more attentive to his own thoughts, and less disturbed by foreign objects, more of his ideas are deducible from association, and fewer from new impressions.

It is to be observed, however, that in all the cases of imagination and reverie the thoughts depend, in part, upon the then state of body or mind. A pleasurable or painful state of the stomach or brain,
joy

joy or grief, will make all the thoughts warp their own way, little or much. But this exception is as agreeable to the foregoing theory, as the general prevalence of association just laid down.

We come next to dreams. I say then, that dreams are nothing but the imaginations, fancies, or reveries of a sleeping man; and that they are deducible from the three following causes, viz. First, The impressions and ideas lately received, and particularly those of the preceding day. Secondly, The state of the body, particularly of the stomach and brain. And, Thirdly, Association.

That dreams are, in part, deducible from the impressions and ideas of the preceding day, appears from the frequent recurrence of these in greater or lesser clusters, and especially of the visible ones, in our dreams. We sometimes take in ideas of longer date, in part, on account of their recency: however, in general, ideas that have not affected the mind for some days, recur in dreams only from the second or third cause here assigned.

That the state of the body affects our dreams, is evident from the dreams of sick persons, and of those who labour under indigestions, spasms, and flatulencies.

Lastly, We may perceive ourselves to be carried on from one thing to another in our dreams partly by association.

It is also highly agreeable to the foregoing theory to expect, that each of the three foregoing causes should have an influence upon the trains of ideas, that are presented in dreams.

Let us now see how we can solve the most usual phenomena of dreams upon these principles.

First, then, The scenes which present themselves are taken to be real. We do not consider them as the work of the fancy; but suppose ourselves present, and actually seeing and hearing what passes.

Now

Now this happens, First, Because we have no other reality to oppose to the ideas which offer themselves, whereas in the common fictions of the fancy, while we are awake, there is always a set of real external objects striking some of our senses, and precluding a like mistake there: or, if we become quite inattentive to external objects, the reverie does so far put on the nature of a dream, as to appear a reality.

— Secondly, The trains of visible ideas, which occur in dreams, are far more vivid than common visible ideas; and therefore may the more easily be taken for actual impressions. For what reasons these ideas should be so much more vivid, I cannot presume to say. I guess, that the exclusion of real impressions has some share, and the increased heat of the brain may have some likewise. The fact is most observable in the first approaches of sleep; all the visible ideas beginning then to be more than usually glaring.

Secondly, There is a great wildness and inconsistency in our dreams. For the brain, during sleep, is in a state so different from that in which the usual associations were formed, that they can by no means take place as they do during vigilance. On the contrary, the state of the body suggests such ideas, amongst those that have been lately impressed, as are most suitable to the various kinds and degrees of pleasant and painful vibrations excited in the stomach, brain, or some other part. Thus a person who has taken opium, sees either gay scenes, or ghastly ones, according as the opium excites pleasant or painful vibrations in the stomach. Hence it will follow, that ideas will rise successively in dreams, which have no such connection as takes place in nature, in actual impressions, nor any such as is deducible from association. And yet, if they rise up quick and vividly one after another, as subjects, predicates, and other associates, use to do, they will be affirmed of each other, and appear to hang together. Thus the same person appears in two places at the same time; two

persons appearing successively in the same place coalesce into one; a brute is supposed to speak (when the idea of a voice comes from that quarter) or to handle; any idea, qualification, office, &c. coinciding in the instant of time with the idea of one's self, or of another person, adheres immediately, &c. &c.

Thirdly, We do not take notice of, or are offended at, these inconsistencies; but pass on from one to another. For the associations, which should lead us thus to take notice, and be offended, are, as it were, asleep; the bodily causes also hurrying us on to new and new trains successively. But if the bodily state be such as favours ideas of anxiety and perplexity, then the inconsistency, and apparent impossibility, occurring in dreams, are apt to give great disturbance and uneasiness. It is to be observed likewise, that we forget the several parts of our dreams, very fast in passing from one to another; and that this lessens the apparent inconsistencies, and their influences.

Fourthly, It is common in dreams for persons to appear to themselves to be transferred from one place to another, by a kind of sailing or flying motion. This arises from the change of the apparent magnitude and position of the images excited in the brain, this change being such as a change of distance and position in ourselves would have occasioned. Whatever the reasons be, for which visible images are excited in sleep, like to the objects with which we converse when awake, the same reasons will hold for changes of apparent magnitude and position also; and these changes in fixed objects, being constantly associated with motions in ourselves when awake, will infer these motions when asleep. But then we cannot have the idea of the *vis inertia* of our own bodies, answering to the impressions in walking; because the nerves of the muscles either do not admit of such miniature vibrations in sleep; or do not transmit

mit ideas to the mind in consequence thereof ; whence we appear to sail, fly, or ride. Yet sometimes a person seems to walk, and even to strike, just as in other cases he seems to feel the impression of a foreign body on his skin.

Those who walk and talk in their sleep, have evidently the nerves of the muscles concerned so free, as that vibrations can descend from the internal parts of the brain, the peculiar residence of ideas, into them. At the same time the brain itself is so oppressed, that they have scarce any memory. Persons who read inattentively, *i. e.* see and speak almost without remembering, also those who labour under such a morbid loss of memory, as that though they see, hear, speak, and act, *pro re nata*, from moment to moment, yet they forget all immediately, somewhat resemble the persons who walk and talk in sleep.

Fifthly, Dreams consist chiefly of visible imagery. This agrees remarkably with the perpetual impressions made upon the optic nerves and corresponding parts of the brain during vigilance, and with the distinctness and vividness of the images impressed.

We may observe also, that the visible imagery in dreams is composed, in a considerable degree, of fragments of visible appearances lately impressed. For the disposition to these vibrations must be greater than to others, *ceteris paribus*, at the same time that by the imperfection and interruption of the associations, only fragments, not whole images, will generally appear. The fragments are so small, and so intermixed with other fragments and appearances, that it is difficult to trace them up to the preceding day ; the shortness of our memory contributing also not a little thereto.

It happens in dreams, that the same fictitious places are presented again and again at the distance of weeks and months, perhaps during the whole course of life. These places are, I suppose, compounded

at first, probably early in youth, of fragments of real places, which we have seen. They afterwards recur in dreams, because the same state of brain recurs; and when this has happened for some successions, they may be expected to recur at intervals during life. But they may also admit of variations, especially before frequent recurrency has established and fixed them.

Sixthly, It has been observed already, that many of the things which are presented in dreams, appear to be remembered by us, or, at least, as familiar to us; and that this may be solved by the readiness with which they start up, and succeed one another, in the fancy.

Seventhly, It has also been remarked, that dreams ought to be soon forgotten, as they are in fact; because the state of the brain suffers great changes in passing from sleep to vigilance. The wildness and inconsistency of our dreams render them still more liable to be forgotten. It is said, that a man may remember his dreams best by continuing in the same posture in which he dreamt; which, if true, would be a remarkable confirmation of the doctrine of vibrations; since those which take place in the medullary substance of the brain would be least disturbed and obliterated by this means.

Eighthly, The dreams which are presented in the first part of the night are, for the most part, much more confused, irregular, and difficult to be remembered, than those which we dream towards the morning; and these last are often rational to a considerable degree, and regulated according to the usual course of our associations. For the brain begins then to approach to the state of vigilance, or that in which the usual associations were formed and cemented. However, association has some power even in wild and inconsistent dreams.

COR. 1. As the prophecies were, many of them, communicated in the way of divine visions, trances, or dreams, so they bear many of the foregoing marks of dreams. Thus they deal chiefly in visible imagery; they abound with apparent impossibilities, and deviations from common life, of which yet the prophets take not the least notice: they speak of new things as of familiar ones; they are carried in the spirit from place to place; things requiring a long series of time in real life, are transacted in the prophetic visions, as soon as seen; they ascribe to themselves and others new names, offices, &c. every thing has a real existence conferred upon it; there are singular combinations of fragments of visible appearances; and God himself is represented in a visible shape, which of all other things must be most offensive to a pious Jew. And it seems to me, that these, and such like criterions might establish the genuineness of the prophecies, exclusively of all other evidences.

COR. 2. The wildness of our dreams seems to be of singular use to us, by interrupting and breaking the course of our associations. For, if we were always awake, some accidental associations would be so much cemented by continuance, as that nothing could afterwards disjoin them; which would be madness.

COR. 3. A person may form a judgment of the state of his bodily health, and of his temperance, by the general pleasantness or unpleasantness of his dreams. There are also many useful hints relating to the strength of our passions deducible from them.

S E C T. VI.

OF IMPERFECTIONS IN THE RATIONAL
FACULTY.

P R O P. XCII.

To examine how far Deviations from sound Reason, and Alienations of Mind, are agreeable to the foregoing Theory.

MAD persons differ from others in that they judge wrong of past or future facts of a common nature; that their affections and actions are violent and different from, or even opposite to, those of others upon the like occasions, and such as are contrary to their true happiness; that their memory is fallacious, and their discourse incoherent; and that they lose, in great measure, that consciousness which accompanies our thoughts and actions, and by which we connect ourselves with ourselves from time to time. These circumstances are variously combined in the various kinds and degrees of madness; and some of them take place in persons of sound minds, in certain degrees, and for certain spaces of time; so that here, as in other cases, it is impossible to fix precise limits, and to determine where soundness of mind ends, and madness begins. I will make some short remarks, deduced from the theory of these papers, upon the following states of mind, which all bear some relation to one another, and all differ from the perfection of reasoning natural to adults, according to the ordinary course of things, viz.

1. The erroneousness of the judgment in children and idiots.
2. The dotage of old persons.
3. Drunkenness.

4. The deliriums attending acute or other distempers.
5. The frequent recurrency of the same ideas in a course of study, or otherwise.
6. Violent passions.
7. Melancholy.
8. Madness.

OF THE ERRONEOUSNESS OF THE JUDGMENT
IN CHILDREN AND IDIOTS.

Children often misrepresent past and future facts; their memories are fallacious; their discourse incoherent; their affections and actions disproportionate to the value of the things desired and pursued; and the connecting consciousness is in them as yet imperfect. But all this follows naturally from the observations made above concerning the methods in which we learn to remember and relate past facts, to judge of future ones, to reason, and to express ourselves suitably to each occasion; also in which our hopes and fears are made to depend upon symbols. No particular account is therefore required for these phenomena; they are strictly natural; and many of the chief reasons for the imperfection of the memory and judgment in children occurring perpetually, and being very obvious, it is not usually supposed, that any particular account is required. However, if an adult should become subject to a like erroneousness, it would evidently be one species of madness; as fatuity or idiotism is. Here the brain labours under such an original disorder, as either not to receive a disposition to the miniature vibrations in which ideas consist, and whence voluntary motions are derived, but with great difficulty; or, if it receives such dispositions readily, they have not the usual permanency; in both which cases it is evident, that the memory, with all the faculties thereon depending, must

continue in an imperfect state, such as is observed in idiots. The want of the connecting consciousness in children and idiots, and indeed in maniacs of various kinds, excites our pity in a peculiar manner, this connecting consciousness being esteemed a principal source and requisite of happiness. Their helplessness, and the dangers to which they are exposed without foreseeing them, contribute also to enhance our compassion.

O F D O T A G E.

The dotage of old persons is oftentimes something more than a mere decay of memory. For they mistake things present for others, and their discourse is often foreign to the objects that are presented to them. However, the imperfection of their memories in respect of impressions but just made, or at short intervals of past time, is one principal source of their mistakes. One may suppose here, that the parts of the brain, in which the miniature vibrations belonging to ideas have taken place, are decayed in a peculiar manner, perhaps from too great use, while the parts appropriated to the natural, vital, and animal motions, remain tolerably perfect. The sinuses of the brain are probably considerably distended in these cases, and the brain itself in a languishing state; for there seems to be a considerable resemblance between the inconsistencies of some kinds of dotage, and those of dreams. Besides which it may be observed, that in dotage the person is often sluggish and lethargic; and that as a defect of the nutritive faculty in the brain will permit the sinuses to be more easily distended, so a distention of the sinuses, from this or any other cause, may impede the due nutrition of the brain. We see that, in old persons, all the parts, even the bones themselves, waste, and grow less. Why may not this happen to the brain, the
origin

origin of all, and arise from an obstruction of the infinitesimal vessels of the nervous system, this obstruction causing such a degree of opacity, as greatly to abate, or even to destroy the powers of association and memory? At the same time vibrations, foreign to the present objects, may be excited from causes residing in the brain, stomach, &c. just as in sleep.

OF DRUNKENNESS.

The common and immediate effect of wine is to dispose to joy, *i. e.* to introduce such kinds and degrees of vibrations into the whole nervous system, or into the separate parts thereof, as are attended with a moderate continued pleasure. This it seems to do chiefly by impressing agreeable sensations upon the stomach and bowels, which are thence propagated into the brain, continue there, and also call up the several associated pleasures that have been formed from pleasant impressions made upon the alimentary duct, or even upon any of the external senses. But wine has also probably a considerable effect of the same kind, after it is absorbed by the veins and lacteals, viz. by the impressions which it makes on the solids, considered as productions of the nerves, while it circulates with the fluids in an unassimilated state, in the same manner, as has been already observed of opium; which resembles wine in this respect also, that it produces one species of temporary madness. And we may suppose, that analogous observations hold with regard to all the medicinal and poisonous bodies, which are found to produce considerable disorders in the mind; their greatest and most immediate effect arises from the impressions made on the stomach, and the disorderly vibrations propagated thence into the brain; and yet it seems probable, that such particles as are absorbed, produce a similar effect in circulating with the blood.

Wine,

Wine, after it is absorbed, must rarefy the blood, and consequently distend the veins and sinuses, so as to make them compress the medullary substance, and the nerves themselves, both in their origin and progress; it must therefore dispose to some degree of a palsy of the sensations and motions; to which there will be a farther disposition from the great exhaustion of the nervous capillaments, and medullary substance, which a continued state of gaiety and mirth, with the various expressions of it, has occasioned.

It is moreover to be noted, that the pleasant vibrations producing this gaiety, by rising higher and higher perpetually, as more wine is taken into the stomach and blood vessels, come at last to border upon, and even to pass into, the disagreeable vibrations belonging to the passions of anger, jealousy, envy, &c. more especially if any of the mental causes of these be presented at the same time.

Now it seems, that, from a comparison of these and such like things with each other, and with what is delivered in other parts of these papers, the peculiar temporary madness of drunken persons might receive a general explanation. Particularly it seems natural to expect, that they should at first be much disposed to mirth and laughter, with a mixture of small inconsistencies and absurdities; that these last should increase from the vivid trains which force themselves upon the brain, in opposition to the present reality; that they should lose the command and stability of the voluntary motions from the prevalence of confused vibrations in the brain, so that those appropriated to voluntary motion cannot descend regularly as usual; but that they should stagger, and see double: that quarrels and contentions should arise after some time; and all end at last in a temporary apoplexy. And it is very observable, that the free use of fermented liquors disposes to passionateness, to distempers of
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the head, to melancholy, and to downright madness; all which things have also great connections with each other.

The sickness and head-ach which drunkenness occasions the succeeding morning, seem to arise, the first from the immediate impressions made on the nerves of the stomach; the second from the peculiar sympathy which the parts of the head, external as well as internal, have with the brain, the part principally affected in drunkenness, by deriving their nerves immediately from it.

OF DELIRIUMS.

I come next to consider the deliriums which sometimes attend distempers, especially acute ones. In these a disagreeable state is introduced into the nervous system by the bodily disorder, which checks the rise of pleasant associations, and gives force and quickness to disgustful ones; and which consequently would of itself alone, if sufficient in degree, vitiate and distort all the reasonings of the sick person. But, besides this, it seems, that, in the deliriums attending distempers, a vivid train of visible images forces itself upon the patient's eye; and that either from a disorder in the nerves and blood vessels of the eye itself, or from one in the brain, or one in the alimentary duct, or, which is most probable, from a concurrence of all these. It seems also, that the wild discourse of delirious persons is accommodated to this train in some imperfect manner; and that it becomes so wild, partly from the incoherence of the parts of this train, partly from its not expressing even this in coherent train adequately, but deviating into such phrases as the vibrations excited by the distemper in the parts of the brain corresponding to the auditory nerves, or in parts still more internal, and consequently the seats of ideas purely intellectual, produce

duce by their associated influence over the organs of speech.

That delirious persons have such trains forced upon the eye from internal causes, appears probable from hence, that when they first begin to be delirious, and talk wildly, it is generally at such times only as they are in the dark, so as to have all visible objects excluded; for, upon bringing a candle to them, and presenting common objects, they recover themselves, and talk rationally, till the candle be removed again. For hence we may conclude, that the real objects overpower the visible train from internal causes, while the delirium is in its infancy; and that the patient relapses, as soon as he is shut up in the dark, because the visible train from internal causes overpowers that which would rise up, was the person's nervous system in a natural state, according to the usual course of association, and the recurrent recollection of the place and circumstances in which he is situated. By degrees the visible train, from internal causes, grows so vivid, by the increase of the distemper, as even to overpower the impressions from real objects, at least frequently, and in a great degree, and so as to intermix itself with them, and to make an inconsistency in the words and actions; and thus the patient becomes quite delirious.

Persons inclining to be delirious in distempers are most apt to be so in going to sleep, and in waking from sleep; in which circumstances the visible trains are more vivid, than when we are quite awake, as has been observed above.

It casts also some light upon this subject, that tea and coffee will sometimes occasion such trains; and that they arise in our first attempts to sleep after these liquors.

As death approaches, the deliriums attending distempers abound with far more incoherences and inconsistencies, than any other species of alienations of the

the mind; which may easily be conceived to be the natural result of the entire confusion and disorder which then take place in the nervous system. However, there are some cases of death, where the nervous system continues free from this confusion to the last, as far as the by-standers can judge.

OF THE FREQUENT RECURRENCY OF THE SAME IDEAS.

When a person applies himself to any particular study, so as to fix his attention deeply on the ideas and terms belonging to it, and to be very little conversant in those of other branches of knowledge, it is commonly observed, that he becomes narrow-minded, strongly persuaded of the truth and value of many things in his own particular study, which others think doubtful or false, or of little importance, and after some time subject to low spirits, and the hypochondriacal distemper. Now all this follows from observations already made. The perpetual recurrency of particular ideas and terms makes the vibrations belonging thereto become more than ordinarily vivid, converts feeble associations into strong ones, and enhances the secondary ideas of dignity and esteem, which adhere to them, at the same time that all these things are diminished in respect of other ideas and terms, that are kept out of view; and which, if they were to recur in due proportion, would oppose and correct many associations in the particular study, which are made not according to the reality of things, and keep down our exorbitant opinions of its importance. The same perpetual recurrency of vibrations, affecting one and the same part of the brain, in nearly one and the same manner, must irritate it at last, so as to enter the limits of pain, and approach to the states peculiar to fear, anxiety, despondency, peevishness, jealousy, and the rest of the tribe of hypochondriacal passions.

Sleep,

Sleep, which presents ideas at hazard, as one may say, and with little regard to prior associations, seems to be of the greatest use in keeping off the hypochondriacal distemper in such persons: however, without a change of studies, this, with great narrow-mindedness, will probably come at last.

It follows from the same method of reasoning, that since the concerns of religion are infinite, so that we can never over-rate them, we ought to make the ideas, motives, and affections, of this kind, recur as often as possible. And if this be done in a truly catholic spirit, with all that variety of actions which our duty to God, our neighbour, and ourselves, requires, there will be no danger of introducing either narrow-mindedness or hypochondriacism. And it ought to be esteemed the same kind and degree of alienation of mind to undervalue a thing of great importance, as to overvalue one of small.

OF VIOLENT PASSIONS.

Persons that are under the influence of strong passions, such as anger, fear, ambition, disappointment, have the vibrations attending the principal ideas so much increased, that these ideas cling together, *i. e.* are associated in an unnatural manner; at the same time that the eagerness and violence of the passion prevent the formation of such associations, or obscure them, if already formed, as are requisite for the right apprehension of the past and future facts, which are the objects of this passion. Violent passions must therefore disorder the understanding and judgment, while they last; and if the same passion returns frequently, it may have so great an effect upon the associations, as that the intervention of foreign ideas shall not be able to set things to rights, and break the unnatural bond. The same increase of vibrations makes all the principal ideas appear to affect

Self,

self, with the peculiar interesting concern supposed to flow from personal identity; so that these vibrations exert a reflected influence upon themselves by this means. And thus it appears, that all violent passions must be temporary madneses, and all habits of them permanent ones, agreeably to the judgment of the wise and good in these things. It appears also, that violent fits of passion, and frequent recurrences of them, must, from the nature of the body, often transport persons, so that they shall not be able to recover themselves, but fall within the limits of the distemper called madness emphatically.

OF MELANCHOLY.

The next species of alienations of the mind is melancholy. Vapours, hypochondriacal and hysterical disorders, are comprehended under this class. The causes of it are self-indulgence in eating and drinking, and particularly in fermented liquors, want of due bodily labour, injuries done to the brain by fevers, concussions, &c. too much application of the mind, especially to the same objects and ideas, violent and long-continued passions, profuse evacuations, and an hereditary disposition; which last we may suppose to consist chiefly in an undue make of the brain.

In women the uneasy states of the *uterus* are propagated to the brain, both immediately and mediately, *i. e.* by first affecting the stomach, and thence the brain. In men the original disorder often begins, and continues for a long time, chiefly in the organs of digestion.

The *causa proxima* of melancholy is an irritability of the medullary substance of the brain, disposing it upon slight occasions to such vibrations as enter the limits of pain; and particularly to such kinds and degrees, as belong to the uneasy passions of fear, sorrow, anger, jealousy, &c. And as these vibrations, when

when the passions are not in great excess, do not much transgress the limits of pleasure, it will often happen that hypochondriac and hysteric persons shall be apt to be transported with joy from trifling causes, and be, at times, disposed to mirth and laughter. They are also very fickle and changeable, as having their desires, hopes, and fears, increased far beyond their natural magnitude, when they happen to fall in with such a state of brain as favours them.

It often happens to these persons to have very absurd desires, hopes, and fears; and yet, at the same time, to know them to be absurd; and, in consequence thereof, to resist them. While they do this, we may reckon the distemper within the bounds of melancholy; but when they endeavour to gratify very absurd desires, or are permanently persuaded of the reality of very groundless hopes and fears, and especially if they lose the connecting consciousness in any great degree, and violate the rules of decency and virtue (the associations of this kind being overpowered, as it were, in the same manner as they are sometimes in dreams), we may reckon the distemper to have passed into madness, strictly so called; of which I now come to speak in a general brief way.

OF MADNESS.

The causes of madness are of two kinds, bodily and mental. That which arises from bodily causes is nearly related to drunkenness, and to the delirium attending distempers. That from mental causes is of the same kind with temporary alienations of the mind during violent passions, and with the prejudices and opinionativeness, which much application to one set of ideas only occasions.

We may thus distinguish the causes for the more easy conception and analysis of the subject; but, in fact, they are both united for the most part. The
bodily

bodily cause lays hold of that passion or affection, which is most disproportionate; and the mental cause, when that is primary, generally waits till some bodily disorder gives it full scope to exert itself. Agreeably to this, the prevention and cure of all kinds of madness require an attention both to the body and mind; which coincides in a particular manner with the general doctrine of these papers.

It is observed, that mad persons often speak rationally and consistently upon the subjects that occur, provided that single one which most affects them, be kept out of view. And the reason of this may be, that whether they first became mad, because a particular, original, mental uneasiness falls in with an accidental, bodily disorder; or because an original, bodily disorder falls in with an accidental mental one; it must follow, that a particular set of ideas shall be extremely magnified, and, consequently, an unnatural association of sameness or repugnancy between them generated, all other ideas and associations remaining nearly the same. Thus, suppose a person, whose nervous system is disordered, to turn his thoughts accidentally to some barely possible good or evil. If the nervous disorder falls in with this, it increases the vibrations belonging to its idea so much, as to give it a reality, a connection with *self*. For we distinguish the recollection and anticipation of things relating to ourselves, from those of things relating to other persons, chiefly by the difference of strength in the vibrations, and in their coalescences with each other. When one false position of this kind is admitted, it begets more of course, the same bodily and mental causes also continuing; but then this process stops after a certain number of false positions are adopted from their mutual inconsistency (unless the whole nervous system be deranged); and it is often confined to a certain kind, as the irascible, the terrifying, &c.

The memory is often much impaired in madness, which is both a sign of the greatness of the bodily disorder, and a hindrance to mental rectification; and therefore a bad prognostic. If an opposite state of body and mind can be introduced early, before the unnatural associations are too much cemented, the madness is cured; if otherwise, it will remain, though both the bodily and mental cause should be at least removed.

Inquiries after the philosopher's stone, the longitude, &c. to which men are prompted by strong ambitious, or covetous desires, are often both cause and effect, in respect of madness. Excessive fits of anger and fear are also found often to hurry persons into madness.

In dissections after madness the brain is often found dry, and the blood vessels much distended; which are arguments, that violent vibrations took place in the internal parts of the brain, the peculiar residence of ideas and passions; and that it was much compressed, so as to obstruct the natural course of association.

As in mad persons the vibrations in the internal parts of the brain are preternaturally increased, so they are defective in the external organs, in the glands, &c. Hence, maniacs eat little, are costive, make little water, and take scarce any notice of external impressions. The violence of the ideas and passions may give them great muscular strength upon particular occasions, when the violent vibrations descend from the internal parts of the brain into the muscles, according to former associations of these with the voluntary motions (the same increase of vibrations in the internal parts of the brain which hinders the ascending vibrations of sensation, augmenting the descending ones of motion). But maniacs are often very sluggish, as well as insensible, from the great prevalence of the ideal vibrations; just as persons in a state of deep attention are. An accurate history of the several kinds

kinds of madness from those physicians, who are much conversant with this distemper, is greatly wanted, and it would probably receive considerable light from this theory.

Religious considerations are the best preservative in hereditary or other tendencies to madness;—as being the only sure means of restraining violent passions, at the same time that they afford a constant indefinite hope, mixed with a filial awe and fear;—which things are eminently qualified to keep up a steadiness and sobriety of mind, and to incite us to such a course of action, as adds incessantly to the hope, and diminishes the fear. However, bodily labour, with a variety of mental occupations, and a considerable abstemiousness in the quantity and quality of diet, ought always to be joined.

S E C T. VII.

OF THE INTELLECTUAL FACULTIES
OF BRUTES.

P R O P. XCIII.

To examine how far the Inferiority of Brutes to Mankind in intellectual Capacities is agreeable to the foregoing Theory.

IF the doctrines of vibrations and association be found sufficient to solve the phænomena of sensation, motion, ideas, and affections, in men, it will be reasonable to suppose, that they will also be sufficient to solve the analogous phænomena in brutes. And, conversely, it seems probable, that an endeavour to apply and adapt these doctrines to brutes will cast some light and evidence upon them, as they take place in men. and thus the laws of vibrations and association may be as universal in respect of the nervous systems of animals of all kinds, as the law of circulation is with respect to the system of the heart and blood vessels; and their powers of sensation and motion be the result of these three laws, viz. circulation, vibrations, and association, taken together. These three laws may also be most closely united in their ultimate cause and source, and flow in all their varieties from very simple principles. At least this is the tenor of nature in many similar cases.

As the whole brute creation differs much from, and is far inferior to man, in intellectual capacities; so the several kinds of animals differ much from each other in the same respect. But I shall, in this section, confine myself chiefly to the consideration of

of the first difference, viz. of that between mankind and the brute creation in general; and endeavour to assign such reasons for it, as flow from, or are agreeable to, the theory of these papers. We may suppose then, that brutes in general differ from, and are inferior to man, in intellectual capacities, on the following accounts:

First, The small proportional size of their brains.

Secondly, The imperfection of the matter of their brains, whereby it is less fitted for retaining a large number of miniatures, and combining them by association, than man's.

Thirdly, Their want of words, and such like symbols.

Fourthly, The instinctive powers which they bring into the world with them, or which rise up from internal causes, as they advance towards adult age.

Fifthly, The difference between the external impressions made on the brute creation, and on mankind.

First, then, As the brains of brutes are less in proportion to the bulk of the other parts, than those of men; and as the internal parts of the brain appear from these papers to be the peculiar seat of ideas, and intellectual affections; it seems very natural to expect, that brutes should have a far less variety of these than men. The parts which intervene between the optic and auditory nerves, being proportionably less, for instance, in brutes, will not admit of so great a variety of associations between the several ideas of these senses, because the optic and auditory nerves cannot have so great a variety of connections and communications with each other.

To this it is to be added, that the internal parts belonging to the olfactory nerves, and, perhaps, those belonging to the nerves of taste, take up, probably, a greater proportional part of the medullary substance of the brain than in us, since most brutes

have the sense of smell, and perhaps that of taste in greater perfection than we have. There will therefore be still less room left for the variety of intercourses between the optic and auditory nerves in the medullary substance of the brain. And yet it is evident, from obvious observations, as well as from the whole tenor of these papers, that the eye and ear, with their associations, are the chief sources of intellect; and that the greatest part of the pleasures and pains of human life arise from visible and audible impressions, which in themselves afford neither pleasure nor pain.

Thus it is natural to expect, that the happiness and misery of brutes should depend principally, and in a direct manner, on the impressions made upon their gross senses, whilst that of mankind arises, in great measure, from long trains of associated ideas and emotions, which enter chiefly by the eye and ear. And it seems to me a very striking coincidence, that mankind should at the same time exceed the brute creation in the variety of their ideas, and in the proportional largeness of that part of the body which is the peculiar seat of these.

The same proportional largeness may, as it were, detain the vibrations which ascend from external impressions up to the brain, and so prevent that freedom of descent into the muscular system which takes place in brutes; and which disposes them to move more early, and more readily, in consequence of direct impressions, than men, at the same time that they have a far less command, in respect of voluntary motion. But this difference depends, in great measure, upon the considerations that follow, as will be seen.

Secondly, That the very constitution and texture of the nervous system, in its infinitesimal vessels, should differ in brutes from that of men, appears highly reasonable to be expected. And since the lives of brutes fall, in general, far short of that of man,

man, also since the quadrupeds (which resemble man more than other animals) are far more hairy, and fowls have feathers, it appears probable, that the texture of the nervous system in brutes should tend more to callosity, and fixedness, in its dispositions to vibrate, than in men. The brains of young brute animals will therefore be sooner able to retain miniatures than those of children, as tending more to firmness and fixedness in their ultimate texture and constitution; at the same time that this texture will unfit them for receiving a variety. To which, if we add the shortness of their lives, and consequently of their ascent to the summit of adult age; which ascent is the proper time for receiving instruction; it is easy to see, that on this double account, as well as that mentioned under the foregoing head, they must fall far short of mankind in the number of their intellectual ideas, pleasures, and pains.

It follows from the same method of reasoning, that the few dispositions to miniature vibrations, which are generated in brutes, may be as perfect in their kinds; and consequently the memory, and short, direct ratiocination depending thereon, as perfect also, as the analogous things in man. Nay, they may be more so, if the particular animal under consideration excel man in the acuteness and precision of those senses, whose ideas make a principal part of this ratiocination. Now it appears, that most quadrupeds exceed us in the acuteness of the smell, and in the power of distinguishing a variety of smells. And many birds seem to be able to see distinctly at much greater distances. However, our auditory nerves, and the regions of the brain corresponding thereto, appear far better fitted for retaining a variety of miniatures of articulate sounds; and our optic nerves, and the regions of the brain corresponding thereto, for retaining a variety of miniatures of shapes and colours. And, next to man, quadru-

peds, and particularly monkeys, dogs, and horses, seem to have these regions of the brain in the greatest perfection.

If the texture of the brains of animals here considered be also, in part, the cause of their being covered with hair, wool, bristles, feathers, &c. it may, from this its effect, dispose them to greater strength and expertness in their motions, and that more early, than happens to men. For all these are *electric per se*, and consequently may first have a considerable degree of this power communicated to them by the heat of the circulating blood; and then, not being able to transmit it to the air, which is also an *electric per se*, may reflect it upon the muscles, and thereby dispose them to somewhat greater activity. It is well known, that the manes of horses, and backs of cats, are made electric by their vital powers. It may farther be observed, that the hoofs of animals are *electric per se*, and that the feathers of water-fowl repel the water; whence the electric virtue may be kept from running off to the earth and water respectively. However, we ought not to lay much stress upon this electric virtue in the muscular fibres of brutes (if there be any such virtue) in order to account for the superior and more early power of animals, in respect of ordinary motions. The texture of the fibres of the muscles, and that of the brain, must have the principal share in this effect.

It is also to be considered, that as they have far fewer voluntary motions, on account of having far fewer ideas, so they may arrive at a greater perfection in the automatic ones, and the small number of voluntary ones which they do perform, on this account. Man is distracted, as it were, by the endless variety of his ideas, and voluntary motions: and it is notorious, that none besides extraordinary geniuses arrive at perfection in any considerable variety; whereas a person of small natural capacity, by selecting some

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one branch of science, or manual art, and applying himself to this alone, may perform wonders. Nay, there have been instances of persons not much removed from idiotism, who could perform the arithmetical operations by memory, far better than men of good understandings, well versed in those operations; which is a thing somewhat analogous to the extraordinary sagacity in investigating and concluding, which brutes discover, in respect of some particular things.

Thirdly, The next circumstance, which renders brutes far inferior to man in intellectual acquisitions, is their want of symbols, such as words, whereby to denote objects, sensations, ideas, and combinations of ideas. This may appear from several considerations. Those men who happen to be born in a country where the mother-tongue is copious and precise, who apply themselves to the study of their mother-tongue, who, besides this, learn one or more foreign tongues, &c. get, by these means, a considerable share of the knowledge of things themselves, learn to remark, prove, disprove, and invent, and, *ceteris paribus*, make a quicker progress in mental accomplishments, than others. On the contrary, the mental improvement of persons born deaf is extremely retarded by their incapacity of having things suggested by articulate sounds, or the pictures of these, and also by their not being able to solve the inverse problem, and denote their own trains of thought by adequate symbols. Words are the same kind of helps in the investigation of qualities, as algebraical symbols and methods are in respect of quantity, as has been already remarked. Persons born deaf cannot therefore make any great progress in the knowledge of causes and effects, in abstracted and philosophical matters; but must approach, as it were, to the state of the brute creation. On the contrary, brute creatures, that have much intercourse with mankind, such as dogs and horses, by learning the

the use of words and symbols of other kinds, become more sagacious than they would otherwise be.

And if particular pains be taken with them, their docility and sagacity, by means of symbols, sometimes arise to a very surprizing degree.

Parrots might be thought, according to this view of the present subject, to have some particular advantages over quadrupeds, by their being able to pronounce words; since, as has been observed before, the attempts which children make to apply words to things, assist them very much in understanding the applications made by others. But parrots do not seem to speak from any particular acuteness and precision in the auditory nerves, and parts of the brain corresponding thereto, having no cochlea, but from the perfection and pliability of their vocal organs, in which they exceed other birds; as birds in general do beasts. And it is reasonable to think, that quadrupeds, which resemble man so nearly in the make of the organ of hearing, as well as in other parts, and which also have naturally much more intercourse with man (being fellow-inhabitants of the earth) than birds (which inhabit the air), should likewise have a greater faculty of distinguishing the articulate sounds of man's voice, retaining their miniatures, and applying them to the things signified, than birds; which seems evidently to be the case. Sagacious quadrupeds may therefore be said to resemble dumb persons arrived at adult age, who are possessed of much knowledge, which yet they cannot express, except by gestures, by dumb shew: whereas parrots, as before remarked, resemble children; these having many words with very little knowledge annexed to them.

Apes and monkeys, of the several kinds, seem to approach nearest to man, in the general faculty of reasoning, and drawing conclusions; but in particular things, especially where instinct prevails, some
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other brutes far exceed them; as indeed such brutes do man himself in a few, on account of the peculiar acuteness of the sense of smell, and the same instinct.

I reckon the want of articulate sounds to be one of the reasons why brutes are so much inferior to men in intellectual capacities; because it appears, from the foregoing and other considerations of the same kind, that it is so. But this is no imperfection upon the whole. The proportional smallness of their brains, the texture of these, their instincts, and their external circumstances, are such, that they do not want language much; that they could make no great use of it, had they proper organs for speaking; and that they would probably be losers, upon the whole, by having it. The efficient and final causes are here suited to each other, as in all other cases; so that no circumstance can be changed for the better, *ceteris manentibus*.

Fourthly, Let us come to the instinctive powers of animals. These are a point of a very difficult consideration. They are evidently not the result of external impressions by means of the miniatures of these, their associations and combinations, in the manner according to which I have endeavoured to shew, that the rational faculties of mankind are formed and improved; and yet, in the instances to which they extend, they very much resemble the rational faculties of mankind. Animals, in preparing and providing for themselves and their young, in future exigencies, proceed in the same manner as a person of good understanding, who foresaw the event, would do; and this, even though they be a little put out of their way. And in this they much resemble persons of narrow capacities and acquisitions, who yet excel greatly in some particular art or science; of which there are many instances. Such persons shew great ingenuity in the things to which they are accustomed,
and

and in some others that border upon them within certain limits, so as to shew great ingenuity still, though put a little out of their way ; but if they be put much out of their way, or questioned about things that are entirely foreign to the art or science in which they excel, they are quite lost and confounded.

Let us suppose this to be the case, and then the inquiry concerning instinct in brutes will be reduced to this, viz. By what means the nervous systems of brutes are made to put on dispositions to miniature vibrations, analogous to those which take place in the persons here considered ; and which are in them the result of foregoing impressions, if we admit the theory of these papers. Now, to me, there seems no difficulty in ascribing this to the mere bodily make in brutes, so that miniature vibrations, such as answer in us to ideas, and voluntary motions, shall spring up in them at certain ages and seasons of the year, and mix themselves with impressions, and acquired ideas, so as to be, in general, suitable to them ; and, in general, to direct the brute creatures in what manner to provide for, and preserve themselves and their young.

This would be a kind of inspiration to brutes, mixing itself with, and helping out, that part of their faculties which corresponds to reason in us, and which is extremely imperfect in them. Only this inspiration might be called natural, as proceeding from the same stated laws of matter and motion as the other phænomena of nature ; whereas the inspiration of the sacred writers appears to be of a much higher source, so as to be termed supernatural properly, in contradistinction to all knowledge resulting from the common laws of nature. And yet it may result from some higher laws of nature. For sacred inspiration would lose nothing of its authority, though it should appear to be within such laws, as by their fixedness might be termed nature : and indeed all differences

differences in these things, after the facts are once settled, will be found, upon due inquiry, to be merely verbal.

Fifthly, The last cause here assigned for the great difference and inferiority of brutes, in respect of intellectual capacities, is the difference in the events and incidents of their lives. They converse with far fewer objects than men, and both the objects and pleasures of feeling, taste, and smell, have a far greater proportional share in the sum total, than in us. Now, as in men, the common events and incidents of life give a turn to the whole frame of mind, and either enlarge the intellectual capacities, if they be various, or narrow them, if the same occurrences return again and again perpetually; so, independently of all the foregoing considerations, the sameness, paucity, and relation to mere sense, of the impressions made on brutes, must infer a great narrowness of understanding.

From all these things put together, it appears very conceivable, how the mental faculties of brutes should, consistently with the doctrines of vibrations and association, be what they are, in fact, found to be. And though I suppose with *Descartes*, that all their motions are conducted by mere mechanism; yet I do not suppose them to be destitute of perception, but that they have this in a manner analogous to that which takes place in us; and that it is subjected to the same mechanical laws as the motions. Whether the ideal vibrations, which take place in the medullary substances of their brains, be the result of former impressions, or the mere offspring of their vital and natural powers, agreeably to the foregoing hypothesis concerning instinct, or the compound effect of both, which we may presume to be generally the case, I always suppose, that corresponding feelings, and affections of mind, attend upon them, just as in us. And the brute creatures prove their near relation to
us,

us, not only by the general resemblance of the body, but by that of the mind also; inasmuch as many of them have most of the eminent passions in some imperfect degree, and as there is, perhaps, no passion belonging to human nature, which may not be found in some brute creature in a considerable degree.

The brutes seem scarce ever able to arrive at any proper self-interest of the abstract and refined kind, at consciousness, so as to compare and connect themselves with themselves in different situations, or at any idea and adoration of God; and this from the narrowness of their capacities and opportunities in general, but particularly from their want of symbols.

The same want of symbols must make all their reasonings and affections, which resemble ours in the general, be, however, considerably different in particulars, and far less complex; but it is sufficient to entitle them to the names of sagacity, cunning, fear, love, &c, by which ours are denoted, that the trains of ideal vibrations in their brains bear a general resemblance to the corresponding ones in ours, spring from like causes, and produce like effects.

The power of association over brutes is very evident in all the tricks which they are taught; and the whole nature of each brute, which has been brought up amongst others of the same species, is a compound of instinct, his own observation and experience, and imitation of those of his own species. Instinct seems to have exerted its whole influence when the creature is arrived at maturity, and has brought up young; so that nothing new can be expected from it afterwards. But their intellectual acquisitions from observation and imitation continue; whence old brutes are far more cunning, and can act far better, *pro re nata*, than young ones.

It ought always to be remembered in speaking on this subject, that brutes have more reason than they can shew, from their want of words, from our in-
attention,

attention, and from our ignorance of the import of those symbols, which they do use in giving intimations to one another, and to us.

We seem to be in the place of God to them, to be his vicegerents, and empowered to receive homage from them in his name. And we are obliged by the same tenure to be their guardians and benefactors.

C H A P IV.

*Of the SIX CLASSES of INTELLECTUAL PLEASURES
and PAINS.*

I HAVE now dispatched the history and analysis of the sensations, motions, and ideas; and endeavoured to suit them, as well as I could, to the principles laid down in the first chapter. My next business, is to inquire particularly into the rise and gradual increase of the pleasures and pains of imagination, ambition, self-interest, sympathy, theopathy, and the moral sense; and to see how far these can be deduced, in the particular forms and degrees that are found to prevail, in fact, from the sensible pleasures and pains, by means of the general law of association. As to that of vibrations, it seems of little importance in this part of the work, whether it be adopted or not. If any other law can be made the foundation of association, or consistent with it, it may also be made consistent with the analysis of the intellectual pleasures and pains, which I shall here give. I do not think there is any other law that can; on the contrary, there seems to be so peculiar an aptness in the doctrine of vibrations, for explaining many of the phenomena of the passions, as almost excludes all others.

Now it will be a sufficient proof, that all the intellectual pleasures and pains are deducible ultimately

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from the sensible ones, if we can shew of each intellectual pleasure and pain in particular, that it takes its rise from other pleasures and pains, either sensible or intellectual. For thus none of the intellectual pleasures and pains can be original. But the sensible pleasures and pains are evidently originals. They are therefore the only ones, *i. e.* they are the common source from whence all the intellectual pleasures and pains are ultimately derived.

When I say, that the intellectual pleasures *A* and *B* are deducible from one another, I do not mean, that *A* receives back again from *B* that lustre which it had conferred upon it; for this would be to argue in a circle; but that whereas both *A* and *B* borrow from a variety of sources, as well as from each other, they may, and indeed must, transfer by association part of the lustre borrowed from foreign sources upon each other.

If we admit the power of association, and can also shew, that associations, sufficient in kind and degree, concur, in fact, in the several instances of our intellectual pleasures and pains, this will, of itself, exclude all other causes for these pleasures and pains, such as instinct for instance. If we cannot trace out associations sufficient in kind and degree, still it will not be necessary to have recourse to other causes, because great allowances are to be made for the novelty, complexness, and intricacy of the subject. However, on the other hand, analogy may perhaps lead us to conclude, that as instinct prevails much, and reason a little in brutes, so instinct ought to prevail a little in us. Let the facts speak for themselves.

S E C T. I.

OF THE PLEASURES AND PAINS OF
IMAGINATION.

I BEGIN with the pleasures and pains of imagination; and shall endeavour to derive each species of them by association, either from those of sensation, ambition, self-interest, sympathy, theopathy, and the moral sense, or from foreign ones of imagination. They may be distinguished into the seven kinds that follow.

First, The pleasures arising from the beauty of the natural world.

Secondly, Those from the works of art.

Thirdly, From the liberal arts of music, painting, and poetry.

Fourthly, From the sciences.

Fifthly, From the beauty of the person.

Sixthly, From wit and humour.

Seventhly, The pains which arise from gross absurdity, inconsistency, or deformity.

P R O P. XCIV.

To examine how far the just-mentioned Pleasures and Pains of Imagination are agreeable to the Doctrine of Association.

Of the PLEASURES arising from the BEAUTY of the
NATURAL WORLD.

THE pleasures arising from the contemplation of the beauties of the natural world seem to admit of the following analysis.

The

The pleasant tastes, and smells, and the fine colours of fruits and flowers, the melody of birds, and the grateful warmth or coolness of the air, in the proper seasons, transfer miniatures of these pleasures upon rural scenes, which start up instantaneously so mixed with each other, and with such as will be immediately enumerated, as to be separately indiscernible.

If there be a precipice, a cataract, a mountain of snow, &c. in one part of the scene, the nascent ideas of fear and horror magnify and enliven all the other ideas, and by degrees pass into pleasures, by suggesting the security from pain.

In like manner the grandeur of some scenes, and the novelty of others, by exciting surprize and wonder, *i. e.* by making a great difference in the preceding and subsequent states of mind, so as to border upon, or even enter the limits of pain, may greatly enhance the pleasure.

Uniformity and variety in conjunction are also principal sources of the pleasures of beauty, being made so partly by their association with the beauties of nature; partly by that with the works of art; and with the many conveniences which we receive from the uniformity and variety of the works of nature and art. They must therefore transfer part of the lustre borrowed from the works of art, and from the head of convenience, upon the works of nature.

Poetry and painting are much employed in setting forth the beauties of the natural world, at the same time that they afford us a high degree of pleasure from many other sources. Hence the beauties of nature delight poets and painters, and such as are addicted to the study of their works, more than others. Part of this effect is indeed owing to the greater attention of such persons to the other sources; but this comes to the same thing, as far as the general

theory of the factitious, associated nature of these pleasures is concerned.

The many sports and pastimes, which are peculiar to the country, and whose ideas and pleasures are revived by the view of rural scenes, in an evanescent state, and so mixed together as to be separately indiscernible, do farther augment the pleasures suggested by the beauties of nature.

To these we may add, the opposition between the offensiveness, dangers, and corruption of populous cities, and the health, tranquillity, and innocence, which the actual view, or the mental contemplation, of rural scenes introduces; also the pleasures of sociability and mirth, which are often found in the greatest perfection in country retirements, the amorous pleasures, which have many connections with rural scenes, and those which the opinions and encomiums of others beget in us, in this, as in other cases, by means of the contagiousness observable in mental dispositions, as well as bodily ones.

Those persons who have already formed high ideas of the power, knowledge, and goodness of the author of nature, with suitable affections, generally feel the exalted pleasures of devotion upon every view and contemplation of his works, either in an explicit and distinct manner, or in a more secret and implicit one. Hence, part of the general indeterminate pleasures, here considered, is deducible from the pleasures of theopathy.

We must not omit in this place to remind the reader of a remark made above, viz. that green, which is the middle colour of the seven primary ones, and consequently the most agreeable to the organ of sight, is also the general colour of the vegetable kingdom, *i. e.* of external nature.

These may be considered as some of the principal sources of the beauties of nature to mankind in general.

neral. Inquisitive and philosophical persons have some others, arising from their peculiar knowledge and study of natural history, astronomy, and philosophy, in general. For the profusion of beauties, uses, fitnesses, elegance in minute things, and magnificence in great ones, exceed all bounds of conception, surprise, and astonishment; new scenes, and those of unbounded extent, separately considered, ever presenting themselves to view, the more any one studies and contemplates the works of God.

And, upon the whole, the reader may see, that there are sufficient sources for all those pleasures of imagination, which the beauties of nature excite in different persons; and that the differences which are found in different persons in this respect, are sufficiently analogous to the differences of their situations in life, and of the consequent associations formed in them.

An attentive person may also, in viewing or contemplating the beauties of nature, lay hold, as it were, of the remainders and miniatures of many of the particular pleasures here enumerated, while they recur in a separate state, and before they coalesce with the general indeterminate aggregate, and thus verify the history now proposed.

It is a confirmation of this history, that an attentive person may also observe great differences in the kind and degree of the relish which he has for the beauties of nature in different periods of his life; especially as the kind and degree may be found to agree in the main with this history.

To the same purpose we may remark, that these pleasures do not cloy very soon, but are of a lasting nature, if compared with the sensible ones; since this follows naturally from the great variety of their sources, and the evanescent nature of their constituent parts.

When a beautiful scene is first presented, there is generally great pleasure from surprize, from being struck with objects and circumstances which we did not expect. This presently declines; but is abundantly compensated afterwards by the gradual alternate exaltation of the several constituent parts of the complex pleasures, which also do probably enhance one another. And thus we may take several reviews of the same scene, before the pleasure, which it affords, comes to its *maximum*. After this the pleasure must decline, if we review it often: but if at considerable intervals, so as that many foreign states of mind intervene, also so as that new sources of the pleasures of this kind be broken up, the pleasure may recur for many successions of nearly the same magnitude.

The same observations hold in respect of the pleasures from the beauties of nature in general, and indeed from all the other sources, works of art, liberal arts, sciences, &c. These all strike and surprize the young mind at first, but require a considerable time before they come to their *maximum*; after which some or other will always be at its *maximum* for a considerable time. However, the pleasures of imagination in general, as well as each particular set and individual, must decline at last from the nature of our frame. In what manner they ought to decline, so as to be consistent with our *summum bonum*, by yielding, in due time, to more exalted and pure pleasures, whose composition they enter, I will endeavour to shew hereafter.

These pleasures are a principal source of those which are annexed to the view of uniformity with variety, as above noted, *i. e.* of analogies of various orders; and consequently are a principal incitement to our tracing out real analogies, and forming artificial ones.

The

The novel, the grand, and the marvellous, are also most conspicuous in the works of nature; and the last strikes us particularly in many of the phenomena of nature, by seeming to exceed all bounds of credibility, at the same time that we are certified by irrefragable evidences of the truth of the facts. The satiety which every pleasure begets in us, after some continuance, makes us thirst perpetually after the grand and novel; and, as it were, grasp at infinity in number and extent; there being a kind of tacit expectation, that the pleasure will be in proportion to the magnitude and variety of the causes, in the same manner as we observe, in other cases, the effects to be in some degree proportional to their causes.

The pleasures of novelty decline not only in this class, but also in all the others sensible and intellectual, partly from our bodily frame, partly from the intermixture, and consequent association of neutral circumstances (*i. e.* such as afford neither pleasure nor pain) in their successive recurrences.

A disposition to a pleasurable state is a general attendant upon health, and the integrity of our bodily faculties; and that in such a degree, as that actual pleasure will spring up from moderate incitements, from the transient introduction of the associated circumstances of former pleasurable states. If the body be indisposed in some degree, it is, however, possible to force it into a state of pleasure by the vivid introduction of various and powerful circumstances; but this unnatural state cannot last long; and, if the indisposition to pleasure be great, it cannot be introduced at all. On the contrary, where the disposition to pleasure is preternaturally prevalent, as after wine and opium, and in certain morbid cases, the least hint will excite profuse joy, leaning chiefly to the pleasures of imagination, ambition, sympathy, or devotion, according to the circumstances.

It is easy to see how the doctrine of vibrations, which appears to be the only one that admits of permanent states of motion, and disposition to motion, in the brain, suits these last remarks in a peculiar manner.

OF THE BEAUTIES OF THE WORKS OF ART.

The works of art, which afford us the pleasures of beauty, are chiefly buildings, public and private, religious, civil, and military, with their appendages and ornaments, and machines of the several kinds, from the great ones employed in war, commerce, and public affairs, such as ships, military engines, machines for manufacturing metals, &c. down to clocks, watches, and domestic furniture. The survey of these things, when perfect in their kinds, affords great pleasures to the curious; and these pleasures increase for a certain time, by being cultivated and gratified, till at last they come to their height, decline, and give way to others, as has been already observed of the pleasures arising from the beauties of nature.

The chief sources of the pleasures, which the fore-mentioned works of art afford, appear to be the following: the beautiful illuminations from gay colours; the resemblance which the playthings, that pleased us when we were children, bear to them; the great regularity and variety observable in them; the grandeur and magnificence of some, and the neatness and elegance of others, and that especially if they be small; the fitness to answer useful ends; their answering a multiplicity of these by simple means, or by analogous complex ones, not exceeding certain limits in complexness; the knowledge conveyed in many cases; the strong associations with religion, death, war, justice, power, riches, titles, high birth, entertainments, mirth, &c. fashion, with the opinions and encomiums of persons supposed to be judges

judges; the vain desire of having a taste, and of being thought connoisseurs and judges, &c. &c.

In architecture there are certain proportions of breadths, lengths, depths, and entire magnitudes, to each other, which are by some supposed to be naturally beautiful, just as the simple ratios of 1 to 2, 2 to 3, 3 to 4, &c. in music, yield sounds, which are naturally pleasant to the ear. But it rather seems to me, that oeconomic convenience first determined the ratios of doors, windows, pillars, &c. in a gross way; and then that the convenience of the artists fixed this determination to some few exact ratios, as in the proportion between the lengths and breadths of the pillars of the several orders. Afterwards these proportions became associated so often with a variety of beauties in costly buildings, that they could not but be thought naturally beautiful at last. In merely ornamental parts the beauty of the proportions seems to arise entirely either from fashion, or from a supposed resemblance to something already fixed as a beautiful proportion. It is easy from these principles to account for the prevalency of different proportions, and general tastes, in different ages and countries.

*Of the PLEASURES arising from MUSIC, PAINTING,
and POETRY.*

Let us next consider the three liberal and sister arts of music, painting and poetry.

O F M U S I C.

Now, in respect of music, it is to be observed, that the simple sounds of all uniform sonorous bodies, and particularly the single notes of the several musical instruments, also all the concords, or notes, whose vibrations bear to each other the simple ratios of 1 to 2, 2 to 3, 3 to 4, &c. sounded together, or near to each

each other, may be considered as originally pleasant to the ear. Discords are originally unpleasant, and therefore, as in other like cases, may be made use of to heighten our pleasures, by being properly and sparingly introduced, so as to make a strong contrast. To which, if we add the uniformity and variety observable in all good music, we shall have the chief pleasures affecting children, and young persons, upon their being first accustomed to hear music.

By degrees the discords become less and less harsh to the ear, and at last even pleasant, at least by their associations with the concords, that go before, or follow them; so that more, and also more harsh discords, are perpetually required to give a relish, and keep the sweetness of the concords from cloying. Particular kinds of air and harmony are associated with particular words, affections, and passions, and so are made to express these; besides which there is often a natural aptitude in the music to represent the affection, as in quick music, and concords, to represent mirth. Music in general is connected with gaiety, public rejoicings, the amorous pleasures, riches, high rank, &c. or with battles, sorrow, death, and religious contemplations. There is an ambition to excel in taste, in performance, and in composition, and a difficulty which enhances the pleasure, &c. &c. till, by these and such like ways, the judgments and tastes of different persons, in respect of music, become as different, as we find them to be in fact.

OF PAINTING.

Our pleasures from pictures are very nearly related to those of imitation, which, as was observed above, take up a considerable part of our childhood; and the several playthings representing men, houses, horses, &c. with which children are so much delighted, are

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to be considered, both as augmenting and gratifying this taste in them.

To this it is to be added, that as the ideas of sight are the most vivid of all our ideas, and those which are chiefly laid up in the memory as keys and repositories to the rest, pictures, which are something intermediate between the real object and the idea, and therefore in cases of sufficient likeness more vivid than the idea, cannot but please us by thus gratifying our desire of raising up a complete idea of an absent object. This an attentive person may observe in himself in viewing pictures.

The surprize and contrast which arise in children, upon their seeing persons and objects present in their pictures, which yet they know to be absent by striking the mind with the impossible conception of the same thing in two places, are probably the sources of considerable pleasure to *them*.

To these causes let us add the gay colours, and fine ornaments, which generally go along with pictures; and we shall have the chief sources of the pleasures which painting affords to young persons, and to those who have not yet been much affected with the various incidents of life, and their representations, or acquired a taste and skill in these things.

For, after this, the pleasures arising from pictures are quite of another kind, being derived from the same sources as those that belong to the scenes, affections, and passions represented, from the poetical descriptions of these, from the precise justness of the imitation, from ambition, fashion, the extravagant prices of the works of certain masters, from association with the villas and cabinets of the noble, the rich, and the curious, &c. &c.

The nature of the caricatura, burlesque, grotesque, picturesque, &c. may be understood from what is delivered in other parts of this section, concerning
laughter,

laughter, wit, humour, the marvellous, absurd, &c. to which they correspond.

Painting has a great advantage over verbal description, in respect of the vividness and number of ideas to be at once excited in the fancy; but its compass is, upon the whole, much narrower; and it is also confined to one point of time.

The representations of battles, storms, wild beasts, and other objects of horror, in pictures, please us peculiarly, partly from the near alliance which the ideas suggested bear to pain, partly from the secret consciousness of our own security, and partly because they awaken and agitate the mind sufficiently to be strongly affected with the other pleasures, which may then be offered to it.

OF POETRY.

The beauties and excellencies of good poetry are deducible from three sources. First, The harmony, regularity, and variety of the numbers or metre, and of the rhyme. Secondly, The fitness and strength of the words and phrases. Thirdly, The subject matter of the poem, and the invention and judgment exerted by the poet, in regard to his subject. And the beauties arising from each of these are much transferred upon the other two by association.

That the versification has of itself a considerable influence, may be seen by putting good poetical passages into the order of prose. And it may be accounted for from what has been already observed of uniformity and variety, from the smoothness and facility with which verses run over the tongue, from the frequent coincidence of the end of the sentence, and that of the verse, at the same time that this rule is violated at proper intervals in all varieties, lest the

ear

ear should be tired with too much sameness, from the assistance which versification affords to the memory, from some faint resemblance which it bears to music, and its frequent associations with it, &c. &c.

The beauties of the diction arise chiefly from the figures; and therefore it will be necessary here to inquire into the sources of their beauties.

Now figurative words seem to strike and please us chiefly from that impropriety which appears at first sight, upon their application to the things denoted by them, and from the consequent heightening of the propriety, as soon as it is duly perceived. For when figurative words have recurred so often as to excite the secondary idea instantaneously, and without any previous harshness to the imagination, they lose their peculiar beauty and force; and, in order to recover this, and make ourselves sensible of it, we are obliged to recall the literal sense, and to place the literal and figurative senses close together, that so we may first be sensible of the inconsistency, and then be more affected with the union and coalescence.

Besides this, figurative expressions illuminate our discourses and writings by transferring the properties, associations, and emotions, belonging to one thing upon another, by augmenting, diminishing, &c. and thus, according as the subject is ludicrous or grave, they either increase our mirth and laughter, or excite in us love, tenderness, compassion, admiration, indignation, terror, devotion, &c.

When figures are too distant, or too obscure, when they augment or diminish too much, we are displeased; and the principal art in the use of figures is, to heighten, as far as the imagination will permit, the greatest beauty lying upon the confines of what disgusts by being too remote or bombast. And this extreme limit for figurative expressions shews evidently, that the pleasure arising from them is nearly

nearly allied to pain; and their beauty owing to a certain kind and degree of inconsistency.

However, as the various figures used in speaking and writing have great influences over each other, alter, and are much altered, as to their relative energy, by our passions, customs, opinions, constitutions, educations, &c. there can be no fixed standard for determining what is beauty here, or what is the degree of it. Every person may find, that his taste in these things receives considerable changes in his progress through life; and may, by careful observation, trace up these changes to the associations that have caused them. And yet, since mankind have a general resemblance to each other, both in their internal make, and external circumstances, there will be some general agreements about these things common to all mankind. The agreements will also become perpetually greater, as the persons under consideration are supposed to agree more in their genius, studies, external circumstances, &c. Hence may be seen, in part, the foundation of the general agreements observable in critics, concerning the beauties of poetry, as well as that of their particular disputes and differences.

It may also be proper to remark here, that the custom of introducing figures in a copious manner into poetry, together with the transpositions, ellipses, superfluities, and high-strained expressions, which the laws of the versification have forced the best poets upon, in some cases, have given a sanction to certain otherwise unallowable liberties of expression, and to a moderate degree of obscurity, and even converted them into beauties. To which it may be added, that a momentary obscurity is like a discord in music properly introduced.

The pleasure which we receive from the matter of the poem, and the invention and judgment of the poet,

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poet, in this respect, arises from the things themselves described or represented. It is necessary therefore, that the poet should choose such scenes as are beautiful, terrible, or otherwise strongly affecting; and such characters as excite love, pity, just indignation, &c. or rather, that he should present us with a proper mixture of all these. For, as they will all please singly, so a well ordered succession of them will much enhance these separate pleasures, by the contrasts, analogies, and coincidences, which this may be made to introduce. In all these things the chief art is to copy nature so well, and to be so exact in all the principal circumstances relating to actions, passions, &c. *i. e.* to real life, that the reader may be insensibly betrayed into a half belief of the truth and reality of the scene.

Verses well pronounced affect us much more, than when they merely pass over the eye, from the imitation of the affections and passions represented, by the human voice; and still much more, when acted well, and heightened by the proper conjunction of realizing circumstances.

Since poetry makes use of words, which are the principal channel of mutual communication for our thoughts and affections, and has by this means an unlimited compass in respect of time, place, &c. it must, upon the whole, have great advantages over painting.

As the pleasures of imagination are very prevalent, and much cultivated, during youth; so, if we consider mankind as one great individual, advancing in age perpetually, it seems natural to expect, that in the infancy of knowledge, in the early ages of the world, the taste of mankind would turn much upon the pleasures of this class. And agreeably to this it may be observed, that music, painting, and poetry, were much admired in ancient times; and the two last brought to great perfection. What was the real per-
fection

fection of the ancient *Grecian* music, also how far the modern very artificial compositions ought to be allowed to excel them, must be left to those who are judges of these matters.

The beauties of oratory are very nearly allied to those of poetry, arising partly from an harmonious flow and cadence of the periods, so that uniformity and variety may be properly mixed, partly from the justness and nervousness of the expressions, and partly from the force of the arguments and motives brought together by the invention of the orator, and so disposed as to convince the judgment, excite and gain the affections. In both cases it is very necessary, that the reader or hearer should conceive favourably of the design and author, in a moral light. Poetry has the advantage of oratory, in respect of the sweetness of the numbers, and boldness of the figures; but oratory, being a real thing, and one which has great influence in many the most important transactions, does, by this reality, affect some persons more than poetry; I mean persons that are mere readers or hearers; for, as to those that are interested in the debate, to whom it is a reality, there can be no doubt.

The beauties of history will easily be understood from what is said of poetry and oratory.

It is to be observed, that poetry, and all fictitious history, borrow one chief part of their influence from their being imitations of real history, as this again does from the strong affections and passions excited by the events of life, and from the contagiousness of our tempers and dispositions.

The same kind of contrasts and coincidences, which, in low and comic things, would be wit or humour, become the brilliant passages that affect and strike us most eminently in grave poetry, in oratory, and history.

OF THE PLEASURES ARISING FROM THE
STUDY OF THE SCIENCES.

The study of the sciences has a great connection with the natural and artificial beauties already considered, and receives great lustre from them in consequence thereof.

But besides this, there are many original sources of pleasure in the study of the sciences: as, First, From the many instances of uniformity with variety: Secondly, From the marvellous and seemingly impossible, which occur in all parts of knowledge: Thirdly, From the great advantages respecting human life, which accrue to mankind in general from the pursuit of knowledge, also from the honours, riches, &c. which are the rewards conferred upon particular persons that are eminent: Lastly, From the numerous connections of truth of all kinds with those most amiable and important doctrines, which religion, natural and revealed, teaches us. And when these pleasures, in their several subordinate kinds and degrees, have been sufficiently associated with the favourite study, they render it at last pleasant in itself, as we usually term it, *i. e.* these several particular pleasures coalesce into a single general one, in which the compounding parts cannot be discerned separately from each other, and which consequently appears to have no relation to its several compounding parts; unless when by a particular attention to, and examination of, what passes in our minds, we lay hold of the last compounding parts before their entire coalescence, or reason upon the causes of these pleasures, by comparing their growth, and the changes made in them, with the concomitant circumstances. Thus, if it be observed as a general fact, that persons grow fond of particular studies, remarkably after having received some great present advantage, or hope of a future one from them, we may reasonably presume,

that the pleasure which they take in these studies, is in part derived from this source, even though it cannot be felt to arise from it explicitly.

OF INVENTION.

The copiousness and quickness of the invention being principal requisites for the cultivation of the arts and sciences with success, I will say something concerning invention here, my subject being now sufficiently opened for that purpose.

Invention then may be defined the art of producing new beauties in works of imagination, and new truths in matters of science. And it seems to depend, in both cases, chiefly upon these three things. First, A strong and quick memory: Secondly, An extensive knowledge in the arts and sciences; and particularly in those that are contiguous to, or not far distant from, that under consideration: And, Thirdly, The habit of forming and pursuing analogies, the deviations from these, and the subordinate analogies visible in many of these first deviations, &c. &c.

First, A strong and quick memory is necessary, that so the ideas of the poet or philosopher may depend upon, and be readily suggested by, each other.

Secondly, He must have a large stock of ideas for the purposes of figures, illustrations, comparisons, arguments, motives, criterions, &c. And it is evident, that the ideas taken from such parts of knowledge, as are pretty nearly allied to his particular study, will be of most use to him in it.

Thirdly, Analogy will lead him by degrees, in works of fancy, from the beauties of celebrated masters to others less and less resembling these, till at last he arrives at such as bear no visible resemblance. Deviations, and the subordinate analogies contained within them, will do this in a much greater degree; and all analogies will instruct him how to model

model properly such entirely new thoughts, as his memory and acquaintance with things have suggested to him. In science analogy leads on perpetually to new propositions; and, being itself some presumption of truth, is a guide much preferable to mere imagination.

It may be observed, that the trains of visible ideas, which accompany our thoughts, are the principal fund for invention, both in matters of fancy, and in science.

As invention requires the three things here spoken of, so, conversely, no person who is possessed of them, and who applies himself to any particular study either of the imaginative or abstract kind, with sufficient assiduity, can fail for want of invention. And the nature of this faculty seems as reconcileable with, and deducible from, the power of association, and the mechanism of the mind here explained, as that of any other.

OF THE BEAUTY OF THE PERSON.

The word *beauty* is applied to the person, particularly in the female sex, in an eminent manner; and the desires and pleasures arising from beauty, in this sense, may be considered as an intermediate step between the gross sensual ones, and those of pure esteem and benevolence; for they are, in part, deduced from both these extremes; they moderate, spiritualize, and improve the first, and, in the virtuous, are ultimately converted into the last.

But they arise also from many other sources in their intermediate state, particularly from associations with the several beauties of nature and art already mentioned, as of gay colours, rural scenes, music, painting, and poetry; from associations with fashion, the opinions and encomiums of others, riches, honours, high birth, &c. from vanity and ambition,

bition, &c. Besides which, the pleasure of gratifying a strong desire, and the pain of disappointment, are to be considered here, as being evidently distinguishable from all the rest in some cases.

That part of beauty which arises from symmetry, may perhaps be said to consist in such proportions of the features of the face, and of the head, trunk, and limbs, to each other, as are intermediate in respect of all other proportions, *i. e.* such proportions as would result from an estimation by an average: one may say at least, that these proportions would not differ much from perfect symmetry.

The desires excited by the beauty of the person increase for some time, especially if the sensible ones are not gratified, and there be also a mixture of hope and fear, in relation to the attainment of the affections of the beloved person. But they sometimes decrease, like other desires, from mere want of novelty, after the affections are gained; and must always do so after gratification. Nevertheless, if there be the proper foundation for esteem and religious affection in each party, mutual love, with the pleasures arising from it, may increase upon the whole, the real circumstances of life affording more than sufficient opportunity for gaining in one respect, what is lost in another.

The beauty of the air, gesture, motions, and dress, has a great connection with the beauty of the person, or rather makes a considerable part of it, contributing much to the sum total; and when considered separately, receiving much from the other part of the beauties of the person. The separate beauty of these things arises from some imitation of a natural or artificial beauty already established, from fashion, high birth, riches, &c. or from their being expressive of some agreeable or amiable quality of mind. The reciprocal influences of our ideas upon each other, and the endless variety of their combinations, are
eminently

eminently conspicuous in this article; the strength of desire here rendering the associations, with the several steps previous to the perfect coalescence of the ideas associated, more visible than in most other cases.

OF WIT AND HUMOUR.

I come now to examine the pleasures of mirth, wit, and humour.

But, First, It will be necessary to consider the causes of laughter, and particularly the mental ones.

Now it may be observed, that young children do not laugh aloud for some months. The first occasion of doing this seems to be a surprize, which brings on a momentary fear first, and then a momentary joy in consequence of the removal of that fear, agreeably to what may be observed of the pleasures that follow the removal of pain. This may appear probable, inasmuch as laughter is a nascent cry, stopped of a sudden; also because if the same surprize, which makes young children laugh, be a very little increased, they will cry. It is usual, by way of diverting young children, and exciting them to laughter, to repeat the surprize, as by clapping the hands frequently, reiterating a sudden motion, &c.

This is the original of laughter in children, in general; but the progress in each particular is much accelerated, and the occasions multiplied, by imitation. They learn to laugh, as they learn to talk and walk; and are most apt to laugh profusely, when they see others laugh; the common cause contributing also in a great degree to produce this effect. The same thing is evident even in adults; and shews us one of the sources of the sympathetic affections.

To these things it is to be added, that the alternate motions of the chest follow the same degrees of mental emotion with more and more facility perpetually, so that at last children (who are likewise more

exquisitely sensible and irritable than adults) laugh upon every trifling occasion.

By degrees they learn the power of suspending the actions both of laughing and crying, and associate this power with a variety of ideas, such as those of decency, respect, fear, and shame: the incidents and objects, which before occasioned emotion sufficient to produce laughter, now occasion little or none, from the transmutation of their associations: their new associated pleasures and pains are of a more sedate kind, and do not affect them so much by surprize; and, which is a principal cause in respect of individuals, their equals laugh less, and, by forming them to the same model with themselves, make the disposition to laughter decrease still faster. For whatever can be shewn to take place at all in human nature, must take place in a much higher degree, than according to the original causes, from our great disposition to imitate one another, which has been already explained.

It confirms this account of laughter, that it follows tickling, as noted above, *i. e.* a momentary pain and apprehension of pain, with an immediately succeeding removal of these, and their alternate recurrency; also that the softer sex, and all nervous persons, are much disposed both to laugh and cry profusely, and to pass quickly from one state to the other. And it may deserve to be inquired, how far the profuse, continued laughter and mirth on one hand, sorrow, hanging the lip, and crying, on the other, which occur in madness, agree with it.

As children learn the use of language, they learn also to laugh at sentences or stories, by which sudden alarming emotions and expectations are raised in them, and again dissipated instantaneously. And as they learnt before by degrees to laugh at sudden unexpected noises, or motions, where there was no fear, or no distinguishable one, so it is after some
time

time in respect of words. Children, and young persons, are diverted by every little jingle, pun, contrast, or coincidence, which is level to their capacities, even though the harshness and inconsistency, with which it first strikes the fancy, be so minute as scarce to be perceived. And this is the origin of that laughter, which is excited by wit, humour, buffoonery, &c.

But this species of laughter abates also by degrees, as the other before considered did, and, in general, for the same causes; so that adults, and especially those that are judges of politeness and propriety, laugh only at such strokes of wit and humour, as surprize by some more than ordinary degree of contrast or coincidence; and have at the same time a due connection with pleasure and pain, and their several associations of fitness, decency, inconsistency, absurdity, honour, shame, virtue, and vice; so as neither to be too glaring on the one hand, nor too faint on the other. In the first case, the representation raises dislike and abhorrence; in the last, it becomes insipid.

From hence may be seen, that in different persons the occasions of laughter must be as different as their opinions and dispositions; that low similitudes, allusions, contrasts, and coincidences, applied to grave and serious subjects, must occasion the most profuse laughter in persons of light minds; and, conversely, increase this levity of mind, and weaken the regard due to things sacred; that the vices of gluttony, lewdness, vain glory, self-conceit, and covetousness, with the concomitant pleasures and pains, hopes, fears, dangers, &c. when represented by indirect circumstances, and the representation heightened by contrasts and coincidences, must be the most frequent subject of mirth, wit, and humour, in this mixed degenerate state, where they are censured upon the whole; and yet not looked upon with a due degree of severity, distance, and abhorrence; that com-

pany, feasting, and wine, by putting the body into a pleasurable state, must dispose to laughter upon small occasions; and that persons who give themselves much to mirth, wit, and humour, must thereby greatly disqualify their understandings for the search after truth; inasmuch as by the perpetual hunting after apparent and partial agreements and disagreements, as in words, and indirect accidental circumstances, whilst the true natures of the things themselves afford real agreements and disagreements, that are very different, or quite opposite, a man must by degrees pervert all his notions of things themselves, and become unable to see them as they really are, and as they appear to considerate sober-minded inquirers. He must lose all his associations of the visible ideas of things, their names, symbols, &c. with their useful practical relations and properties; and get, in their stead, accidental, indirect, and unnatural conjunctions of circumstances, that are really foreign to each other, or oppositions of those that are united; and, after some time, habit and custom will fix these upon him.

— The most natural occasions of mirth and laughter in adults seem to be the little mistakes and follies of children, and the smaller inconsistencies and improprieties, which happen in conversation, and the daily occurrences of life; inasmuch as these pleasures are, in great measure, occasioned, or at least supported, by the general pleasurable state, which our love and affection to our friends in general, and to children in particular, put the body and mind into. For this kind of mirth is always checked where we have a dislike; also where the mistake or inconsistency rises beyond a certain limit; for then it produces concern, confusion, and uneasiness. And it is useful not only in respect of the good effects which it has upon the body, and the present amusement and relaxation that it affords to the mind; but also, because it

puts

puts us upon rectifying what is so amiss, or any other similar error, in one another, or in children; and has a tendency to remove many prejudices from custom and education. Thus we often laugh at children, rustics, and foreigners, when yet they act right, according to the truly natural, simple, and uncorrupted dictates of reason and propriety, and are guilty of no other inconsistency, than what arises from the usurpations of custom over nature; and we often take notice of this, and correct ourselves, in consequence of being diverted by it.

OF INCONSISTENCY, DEFORMITY, AND ABSURDITY.

Having now considered, in a short and general way, all the pleasures that seem properly to belong to the head of imagination, I will say something concerning the pains of this class, viz. those which arise from the view of gross inconsistency, absurdity, and deformity. Here we may observe,

First, That these pains are the root and source of many of the fore-mentioned pleasures, particularly those arising from figurative expressions, and of wit and humour, as has been shewn in treating of these things.

Secondly, That the disgust and uneasiness here considered never rise to any very great height, unless some of the pains of sympathy, or of the moral sense, mix themselves with them. From whence it seems to follow, that the mere *pleasures* of imagination and beauty are also of a kind much inferior to those of sympathy, and the moral sense.

The perplexity, confusion, and uneasiness, which we labour under in abstruse inquiries, philosophical, moral, and religious, ought, perhaps, to be referred to this head. Also the secondary perplexity which arises from our being subject to this perplexity, confusion, and uneasiness. However, all this is to be
accounted

accounted for as any other evil, and does not seem to be attended either with greater or less difficulties. No perplexity can give us more than a limited degree of pain; and all our perplexities have probably both the same general good effects as our other pains; and also, like each of these, some good effects peculiar to themselves.

We may now observe upon the whole, that according to the foregoing history of the pleasures of imagination, there must be great differences in the tastes and judgements of different persons; and that no age, nation, class of men, &c. ought to be made the test of what is most excellent in artificial beauty; nor consequently of what is absurd. The only things that can be set up as natural criterions here seem to be uniformity with variety, usefulness in general, and the particular subserviency of this or that artificial beauty to improve the mind, so as to make it suit best with our present circumstances, and future expectations. How all these criterions consist with each other, and unite in the single criterion of religion, or the love of God, and of our neighbour, understood in the comprehensive sense of these words, I shall endeavour to shew hereafter.

S E C T. II.

OF THE PLEASURES AND PAINS OF AMBITION.

P R O P .XCV.

To examine how far the Pleasures and Pains of Ambition are agreeable to the foregoing Theory.

THE opinions of others concerning us, when expressed by corresponding words or actions, are principal sources of happiness or misery. The pleasures of this kind are usually referred to the head of honour; the pains to that of shame; but as it is most convenient to have a single word, to which to refer both the pleasures and pains of this class, I have made choice of ambition for that purpose. It will therefore be our business, under this proposition, to inquire by what associations it is brought about, that men are solicitous to have certain particulars concerning themselves made known to the circle of their friends and acquaintance, or to the world in general; and certain others concealed from them; also, why all marks and evidences, that these two several kinds of particulars are made known, so as to beget approbation, esteem, praise, high opinion, &c. or dislike, censure, contempt, &c. occasion such exquisite pleasures and pains, as those of honour and shame, *i. e.* of ambition.

The particulars which we desire to have made known to, or concealed from, others, in order to obtain praise, or avoid dispraise, may be classed under the four following heads.

First

First, External advantages or disadvantages.
 Secondly, Bodily perfections and imperfections.
 Thirdly, Intellectual accomplishments or defects.
 Fourthly, Moral ones, *i. e.* virtue or vice.

I will now endeavour to shew what pleasures and pains, bodily and intellectual, are associated with the opinions which others form of us, in these four respects, *i. e.* either with the several methods by which they receive their information; or with those by which they signify their having received it, and their consequent approbation or disapprobation, respect or contempt.

OF EXTERNAL ADVANTAGES AND DISADVANTAGES.

I begin with the consideration of external advantages or disadvantages. The principal of these are fine clothes, riches, titles, and high birth, with their opposites, rags, poverty, obscurity, and low birth.

Now it is evident, that these external advantages and disadvantages become such by being made known to others; that the first gain men certain privileges and pleasures; and the last subject them to inconveniencies and evils only, or chiefly, when they are discovered to the world. It follows therefore that every discovery of this kind to others, also every mark and associate of such discovery, will, by association, raise up the miniatures of the privileges and pleasures, inconveniencies, and evils, respectively; and thus afford, in each instance, a peculiar compound pleasure or pain, which, by the use of language, has the word *honour* or *shame* respectively annexed to it.

This is the gross account of the generation of these pleasures and pains; but the subordinate particulars contain many things worthy of observation.

Thus fine clothes please both children and adults, by their natural or artificial beauty; they enhance
 the

the beauty of the person; they excite the compliments and caresses of the attendants in a peculiarly vivid manner; they are the common associates of riches, titles, and high birth; they have vast encomiums bestowed upon them; and are sometimes the rewards of mental accomplishments and virtue. Rags, on the contrary, are often attended with the most loathsome and offensive ideas, with bodily infirmity, poverty, contempt, and vice. It is easy therefore to see, that in our progress through life, a compound associated desire of fine clothes, and abhorrence of rags, will spring up so early as to be deemed a natural one. And if a person passes of a sudden from rags to fine clothes, or *vice versa*, the pleasure or pain will be enhanced accordingly, by the juxtaposition of the opposites.

Now these pleasures and pains, which thus attend a person's being actually dressed in fine clothes, or in rags, will, by farther associations, be transferred upon all the concomitant circumstances, the possession of fine clothes, the hopes of them, or the fear of rags; and particularly upon all narrations and symbols, whereby others are first informed of the person's dress, or discover their prior knowledge of it; so that the person shall have his vanity gratified, or his shame excited, by all such narrations, and by all the concomitant circumstances and symbols.

Riches, titles, and high birth, are attended with associates of the same kind as fine clothes; with this difference, however, that it requires a farther progress in life to be sufficiently affected with the compound pleasure resulting from the associates of these, and consequently for acquiring a taste for those pleasures of honour, which riches, titles, and high birth afford. Agreeably to which it may be observed, that the first instance of pride and vanity in children is that which arises from fine clothes.

In

In the progress through life, especially in the virtuous, it often happens, that opposite associations are generated, *i. e.* such as break the connection between the ideas of happiness and fine clothes, riches, titles, high birth; also between misery and rags, poverty, obscurity, and low birth; nay, there are some instances in which these last are connected with some kinds and degrees of happiness. Now in all these cases the pride and vanity, or shame, by which we hope or fear to have our circumstances, in these respects, known to the world, lessen, cease entirely, or even turn about to the opposite quarter accordingly; so that when a person has lost his desire of being rich, or high born, he also loses his desire of being thought so; and when he gains an opposite desire of becoming poor, on a religious account, for instance, or a complacency in being low born, on account of his present high station, &c. he desires also to have this known to the world. And yet there may, in most cases, be perceived some distance in time between the desire of *being*, and the subsequent associated desire of *being thought*, viz. such a distance of time as may suffice for the associations to produce their effect in.

Riches are attended with many conveniencies, whether a person be known to possess them, or no; and there are inconveniencies, as well as conveniencies, attending the reputation of being rich; but titles and high birth are then only productive of privileges and pleasures, when made known to the world; whence it is easy to see that pride and vanity may shew themselves much more commonly in respect of titles and high birth, than in respect of riches, which is agreeable to the fact.

The shamefacedness of rustics, poor persons, and inferiors in general, in the presence of their superiors, with the great confusion and uneasiness that often attend it, arises from the sources of honour and shame

shame here laid open, and particularly from the strong contrast between their own circumstances and those of their superiors.

OF BODILY PERFECTIONS AND IMPERFECTIONS.

The chief bodily circumstances, which are the sources of the pleasures of honour, or of the pains of shame, are beauty, strength, and health, on the one hand; and their opposites, deformity, imbecility, unfitting a person for the functions of life, and disease, on the other. I will make some short remarks upon each.

Beauty has an intimate connection with one of the most violent of our desires; affords a great pleasure, even where this desire is not felt explicitly; has the highest encomiums bestowed upon it in books, especially in such as are too much in the hands of young persons, and the highest compliments paid to it in discourse; and is often the occasion of success in life; all which holds more particularly in respect of women, than of men. No wonder therefore, that both sexes, but especially women, should desire both to *be* and *be thought* beautiful, and be pleased with all the associated circumstances of these things; and that the fear of *being* or *being thought* deformed, should be a thing to which the imagination has the greatest reluctance. And the reputation of beauty, with the scandal of deformity, influences so much the more, as beauty and deformity are not attended with their respective pleasing or displeasing associates, except when they are made apparent to, and taken notice of by the world. So that here the original desire is rather to *be thought* beautiful than to *be* so; and this last is chiefly a consequential one arising in our minds, from the close connection of *being* with *being thought*.

In

In strength it is otherwise. This is the source of many conveniencies, and imbecility, its opposite, of many inconveniencies, whether they be taken notice of or no; as well as of some which depend on their being thus taken notice of. It is reasonable therefore here to suppose, that our first and greatest desire should be after the thing itself; and so it is in fact. However, since several advantages arise from shewing our strength; since also the ostentation of happiness of any kind belonging to ourselves, or the notice which others take of it, bring in the pleasing idea with great vigour; it is evident, that there must be eager desires of *being thought* strong, agile, &c. as well as of *being so*. And, by parity of reason, men will be much ashamed of *being thought* weak and feeble, as well as afraid of being so. And as women glory chiefly in beauty, so men do in strength; this being chiefly a source of advantages and pleasures to men, as that is to women. Nay, one may even observe, that any great degree of beauty in men, or strength in women, by being opposite to that perfection, which is peculiar to each sex, is thought rather undesirable than desirable.

Health and sickness have many connections with beauty and strength, deformity and imbecility, respectively; and therefore may easily be conceived to become respectively the sources of the pleasures of honour, or of the pains of shame, agreeably to the fact. But, in diseases, so many greater pains and evils, fears, anxieties, &c. with some pleasures, such as those of friendship, occur likewise, that there is, in most cases, little room for shame to exert itself: however, if the disease be the consequence either of a virtuous, or a vicious, course of action, the honour or shame, belonging to virtue or vice respectively, will be transferred upon it.

There is an high degree of shame, which attends the natural evacuations, particularly those of the *æces* and

and urine, which is in part deduced from the offensiveness of the excrements of the body, and is nearly related to the shame attending bodily infirmities and diseases. But this shame, as it respects the fæces and urine, has also a particular connection with that which relates to the pudenda, arising from the vicinity of the organs; and thus they give and receive mutually. They are also both of them much increased by education, custom, and the precepts and epithets of parents and governors. The original sources of the shame relating to the pudenda are probably the privacy requisite (which is both cause and effect), the greatness of the pleasure, and the sense of guilt which often attends; and there may be perhaps something of instinct, which operates here quite independently of association.

OF INTELLECTUAL ACCOMPLISHMENTS AND DEFECTS.

The intellectual accomplishments and defects which occasion honour and shame, are sagacity, memory, invention, wit, learning; and their opposites, folly, dulness, and ignorance. Here we may deduce a considerable part from the many advantages arising from the accomplishments, disadvantages from the defects, in the same manner as has been done already in the two foregoing articles. But a great part, perhaps the greatest, is deduced from the high-strained encomiums, applauses, and flatteries, paid to parts and learning, and the outrageous ridicule and contempt thrown upon folly and ignorance, in all the discourses and writings of men of genius and learning; these persons being extremely partial to their own excellencies, and carrying the world with them by the force of their parts and eloquence. It is also to be observed, that in the education of young persons, and especially of boys and young men, great rewards are conferred in consequence of intellectual

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attainments and parts; and great punishments follow negligence and ignorance; which rewards and punishments, being respectively associated with the words expressing praise and censure, and with all their other circumstances, transfer upon praise and censure compound vivid miniatures, pleasant and painful.

In like manner all the kinds of honour and shame, by being expressed in words and symbols, that are nearly related to each other, enhance each other: thus, for instance, the caresses given to a child when he is dressed in fine clothes prepare him to be much more affected with the caresses and encomiums bestowed upon him when he has been diligent in getting his lesson, and indeed it ought to be remarked, that the words and phrases of the parents, governors, superiors, and attendants, have so great an influence over children, when they first come to the use of language, as instantly to generate an implicit belief, a strong desire, or a high degree of pleasure. They have no suspicions, jealousies, memories, or expectations of being deceived or disappointed; and therefore a set of words expressing pleasures of any kind, which they have experienced, put together in almost any manner, will raise up in them a pleasurable state, and opposite words a painful one. Whence it is easy to see, that the fine language expressing praise, and the harsh one expressing dispraise, must instantly, from the mere associations heaped upon the separate words, put them into a state of hope and joy, fear and sorrow, respectively. And when the foundation is thus laid, praise and dispraise will keep their influences from the advantages and disadvantages attending them, though the separate words should lose their particular influences, as they manifestly do in our progress through life.

The honour and shame arising from intellectual accomplishments do often, in learned men, after some time, destroy, in great measure, their sensibility, in
respect

respect of every other kind of honour and shame; which seems chiefly to arise from their conversing much with books, and learned men, so as to have a great part of the pleasures, which they receive from this their conversation, closely connected with the encomiums upon parts and learning; also to have all terms of honour applied to them, and the keenest reproach, and most insolent contempt, cast upon the contrary defects. And, as the pleasures which railery, ridicule, and satire, afford to the by-standers, are very considerable, so the person who is the object of them, and who begins to be in pain upon the first slight marks of contempt, has this pain much enhanced by the contrast, the exquisiteness of his uneasiness and confusion rising in proportion to the degree of mirth, and insolent laughter in the by-standers: whence it comes to pass, that extremely few persons have courage to stand the force of ridicule; but rather subject themselves to considerable bodily pains, to losses, and to the anxiety of a guilty mind, than appear foolish, absurd, singular, or contemptible to the world, or even to persons of whose judgment and abilities they have a low opinion.

All this is, in general, more applicable to men than to women, just as the honour and shame belonging to beauty and deformity is more applicable to women than men; both which observations are easily deducible from the different talents and situations in life of the two sexes.

OF VIRTUE AND VICE.

We come, in the last place, to consider moral accomplishments and defects, or virtue and vice. Now it is very evident, that the many advantages, public and private, which arise from the first, will engage the world to bestow upon it much honour and applause, in the same manner as the evil consequences

of vice must make *it* the object of censure and reproach. Since therefore the child is affected with the words expressing honour and censure, both from the separate influences of these words, and from the application of phrases of this kind to other subjects of praise and dispraise, he must be affected by the commendations bestowed upon him when he has done well, and by the censures passed on him when he has done ill.

These commendations and censures are also attended with great immediate rewards and punishments, likewise with the hopes and fears relating to another world; and when the moral sense is sufficiently generated, with great secret indeterminate pleasure or pain of this kind; and these associations add a particular force to the honour and shame belonging respectively to virtue and vice. At the same time it is easy to see, that some considerable progress in life is ordinarily required before men come to be deeply and lastingly affected by these things; also that this kind of honour and shame may, at last, from the superior force of the associated pleasures and pains, absorb, as it were, all the other kinds. A religious man becomes at last insensible, in great measure, to every encomium and reproach, excepting such as he apprehends will rest upon him at the last day, from him whose judgment cannot err.

This is the general account of the honour and shame paid to virtue and vice respectively. I will now make a few short strictures upon some of the principal virtues and vices.

First, then, Piety is not in general, and amongst the bulk of mankind, had in great honour. This proceeds from several causes; as that in the order of our progress it is the last of the virtues, and therefore, having few votaries, it must have few advocates; that in the first attempts to attain it, men often fall into great degrees of enthusiasm and superstition, and so

expose

expose themselves to the charges of folly, madness, and self-conceit; and that pretences to it are often made use of by hypocrites to cover the worst designs. Now from these and such like causes it happens, that men are much ashamed to be thought devout, fearing that exquisite uneasiness, which being ridiculed and contemned as fools, madmen, and hypocrites, occasions. At the same time it appears, that amongst those who have made considerable advances in religion, piety will be had in the greatest honour: these see evidently how it may be distinguished from enthusiasm, superstition, and hypocrisy; and are very little solicitous concerning the opinions of the profane world, who are apt to confound them; and therefore as far as their piety will permit any foreign desire to arise, they have an exquisite relish for the honour and esteem proceeding from the reputation of piety.

Benevolence springs up more early in life than piety, and has at first view a more immediate good influence upon society. There are also greater numbers who arrive at some imperfect degrees of it, than who arrive at like degrees of piety; neither are the degenerations and counterfeits of benevolence so common as those of piety. On these accounts much greater and more frequent encomiums are bestowed upon it by the bulk of mankind, than upon piety; and these with the many advantages resulting from the reputation of being benevolent, make most persons eagerly desire this reputation; so that they perform many actions from mere ambition, or from a mixture of this with benevolence, which they desire the world should think to proceed from mere benevolence.

Military glory, and the high applauses bestowed upon personal courage, seem, in a considerable degree, deducible from this source, from the benevolent design of protecting the innocent, the helpless, one's friends and country, from invasions, robberies, wild

beasts, &c. The connection of these with bodily strength, and the characteristical perfections of men as distinguished from women and children, the rarity and difficulty of them, the vast encomiums bestowed upon them by poets, orators and historians, especially in ancient times, *i. e.* by those authors which are read in schools, and lay hold of our pliant imaginations when young, the ridicule cast upon timorousness by boys and men, as not being a common imperfection amongst them, and the connection of the fear of death with the sense of guilt, all concur likewise, and have carried mankind so far as make them confer the highest honours upon the most cruel, lawless, and abominable actions, and consequently incite one another to perform such actions from ambitious views. However, this false glare seems to fade in theory, amongst writers; and one may hope that the practice of mankind will be, in some measure, agreeable to the corrections made in their theory.

Temperance and chastity have considerable honours bestowed upon them; but the shame and scandal attending the opposite vices, and which arise from the loathsome diseases, and the many miseries, which men bring upon themselves and others by these vices, are much more remarkable. The detail of these things might easily be deliverd from parallel observations already made. It happens sometimes, that some degrees of these vices are looked upon by young and ignorant persons, as honourable, from certain connections with manliness, fashion, high life: however, this is still in conformity with the doctrine of association, and the derivation of all the pleasures of honour from happiness under some form or other; and, when the same persons become better instructed in the real consequences and connections of things, their opinions change accordingly.

Negative

Negative humility, or the not thinking better, or more highly, of ourselves than we ought, in respect of external advantages, bodily, intellectual, or moral accomplishments, and being content with such regards as are our due, which is the first step; and then positive humility, or a deep sense of our own misery and imperfections of all kinds, and an acquiescence in the treatment which we receive from others, whatever it be; being virtues which are most commodious to ourselves and others, and highly amiable in the sight of all those who have made a due proficiency in religion, and the moral sense, come at last to be honoured and esteemed in an eminent manner, and consequently to incite men from mere vanity and ambition to seek the praise of humility. And the ridicule and shame which attend vanity, pride, and self-conceit, concur to the same purpose; which is a remarkable instance of the inconsistency of one part of our frame with itself, as the case now stands, and of the tendency of vice to check and destroy itself.

From the whole of what has been delivered upon this class of pleasures and pains, one may draw the following corollaries.

COR. I. All the things in which men pride themselves, and for which they desire to be taken notice of by others, are either means of happiness, or have some near relation to it. And indeed it is not at all uncommon to see persons take pains to make others believe, that they are happy, by affirming it in express terms. Now this, considered as a mere matter of fact, occurring to attentive observation, might lead one to conclude, that the pleasures of honour and ambition are not of an original, instinctive, implanted nature, but derived from the other pleasures of human life, by the association of these into various parcels, where the several ingredients are so mixed amongst one another, as hardly to be discernible separately.

The young, the gay, and the polite, are ambitious of being thought beautiful, rich, high born, witty, &c. The grave, the learned, the afflicted, the religious, &c. seek the praise of wisdom and knowledge, or to be esteemed for piety and charity; every one according to his opinions of these things, as the sources, marks, or offsprings of happiness. And when men boast of their poverty, low birth, ignorance, or vice, it is always in such circumstances, with such additions and contrasts, or under such restrictions, as that the balance, upon the whole, may, some way or other, be the more in their favour on that account.

COR. 2. Praise and shame are made use of by parents and governors, as chief motives and springs of action; and it becomes matter of praise to a child, to be influenced by praise, and deterred by shame; and matter of reproach, to be insensible in these respects. And thus it comes to pass, that praise and shame have a strong reflected influence upon themselves; and that praise begets the love of praise, and shame increases the fear of shame. Now, though the original praise, commendation, blame, censure, &c. of good parents and preceptors, extend only, for the most part, to acquired accomplishments and defects, and particularly to virtue and vice; yet the secondary influence will affect men in respect of all sorts of encomiums and censures, of every thing that comes under the same denomination, that is associated with, or tied up by, the same words. Though the preceptor direct his pupil only to regard the judgment of the wise and good, still there are so many like circumstances attending the judgment of others, that it will be regarded something the more from the lessons received, in respect of the wise and good, exclusively of others.

COR.

COR. 3. In considering the sources of honour and shame it will appear, that they are by no means consistent with one another; and, by a farther inquiry, that the *maximum* of the pleasures of this class ultimately coincides, *omni ex parte*, with moral rectitude.

S E C T. III.

OF THE PLEASURES AND PAINS OF SELF-INTEREST.

P R O P. XCVI.

To examine how far the Pleasures and Pains of Self-interest are agreeable to the foregoing Theory.

SELF-INTEREST may be distinguished into three kinds, viz.

First, Gross self-interest, or the cool pursuit of the means whereby the pleasures of sensation, imagination, and ambition, are to be obtained, and their pains avoided.

Secondly, Refined self-interest, or a like pursuit of the means that relate to the pleasures and pains of sympathy, theopathy, and the moral sense.

And, Thirdly, Rational self-interest, or the pursuit of a man's greatest possible happiness, without any partiality to this or that kind of happiness, means of happiness, means of a means, &c.

OF GROSS SELF-INTEREST.

The love of money may be considered as the chief species of gross self-interest, and will help us, in an eminent manner, to unfold the mutual influences of our pleasures and pains, with the factitious nature of the intellectual ones, and the doctrine of association in general, as well as the particular progress, windings, and endless redoublings of self-love. For it is evident at first sight, that money cannot
naturally

naturally and originally be the object of our faculties; no child can be supposed born with the love of it. Yet we see, that some small degrees of this love rise early in infancy; that it generally increases during youth and manhood; and that at last, in some old persons, it so engrosses and absorbs all their passions and pursuits, as that from being considered as the representative, standard, common measure and means of obtaining the commodities which occur in common life, it shall be esteemed the adequate exponent and means of happiness in general, and the thing itself, the sum total of all that is desirable in life. Now the monstrous and gigantic size of this passion, in such cases, supported evidently by association alone, will render its progress and growth more conspicuous and striking; and consequently greatly contribute to explain the corresponding particulars in other passions, where they are less obvious.

Let us inquire therefore, for what reasons it is that children first begin to love money. Now they observe, that money procures for them the pleasures of sensation, with such of imagination as they have acquired a relish for. They see that it is highly valued by others; that those who possess it are much regarded and caressed; that the possession of it is generally attended by fine clothes, titles, magnificent buildings, &c. Imitation, and the common contagion of human life, having great power here, as in other cases. Since therefore ideas exciting desire are thus heaped upon money by successive associations perpetually recurring, the desire of it in certain sums and manners, viz. such as have often recurred with the concomitant pleasures, must at last grow stronger than the fainter sensible and intellectual pleasures; so that a child shall prefer a piece of money to many actual gratifications to be enjoyed immediately.

And as all the fore-mentioned associations, or such as are analogous to them, continue during life, it seems

seems probable, that the love of money would at last devour all the particular desires, upon which it is grounded, was it not restrained by counter-associations; just as it was observed above, that the pleasure of gratifying the will would devour all the particular pleasures, to which it is a constant associate, did not repeated disappointments preserve us from this enormous increase of wilfulness.

Let us next examine how the love of money is checked.

First, then, It is checked by the strong desires of young persons, and others, after particular gratifications; for these desires, by overpowering their acquired aversion to part with money, weaken it gradually, and consequently weaken the pleasure of keeping, and the desire of obtaining, all which are closely linked together in this view; notwithstanding that the last, viz. the desire of obtaining, and by consequence (in an inverted order) the pleasure of keeping, and the aversion to part with, are strengthened by the desires of particular pleasures to be purchased by money in another view. And this contrariety of our associations is not only the means of limiting certain passions, but is a mark set upon them by the author of nature, to shew that they ought to be limited, even in our progress through this life; and that they must ultimately be annihilated, every one in its proper order.

Secondly, The insignificancy of riches in warding off death and diseases, also shame and contempt in many cases, and in obtaining the pleasures of religion, and the moral sense, and even those of sympathy, ambition, imagination, and sensation, first lessen their value in the eyes of those who make just observations upon things in their progress through life, and afterwards fix a positive nothingness and worthlessness upon them.

Thirdly,

Thirdly, The eager pursuit of any particular end, as fame, learning, the pleasures of the imagination, &c. leaves little room in the mind either for avarice, or any other foreign end.

Now by these and such like considerations we may account not only for the limitation put to the love of money, but also for certain mixtures of tempers and dispositions, which are often found in fact, and yet seem at first sight inconsistent ones. Thus profuseness, in respect of sensual and selfish pleasures is often joined with avarice. Covetous persons are often rigidly just in paying, as well as exacting; and sometimes generous, where money is not immediately and apparently concerned. They have also moderate passions in other respects; for the most part, are suspicious, timorous, and complaisant. And the most truly generous, charitable, and pious persons, are highly frugal, so as to put on the appearance of covetousness, and even sometimes, and in some things, to border upon it.

We may see also, why the love of money must in general, grow stronger with age; and especially if the particular gratifications, to which the person was most inclined, become insipid or unattainable—Why frequent reflections upon money in possession, and the actual viewing large sums, strengthen the associations by which covetousness is generated—Why children, persons in private and low life, and indeed most others, are differently affected towards the same sum of money, in different forms, gold, silver, notes, &c.

Let us next inquire, for what reasons it is that the love of money has the idea of selfishness attached to it in a peculiar manner, much more so than the pursuit of the pleasures of honour, imagination, or sympathy; whereas all are equally generated by association, from sensible and selfish pleasures, all in their several degrees promote private happiness, and
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are all pursued, in some cases, coolly and deliberately from the prospect of obtaining private happiness thereby. Now the reasons of this seem to be,

First, That whatever riches one man obtains, another must lose; so that the circulation of money by trades, professions, offices, &c. is a kind of gaming; and has most of the same disgustful ideas annexed to it, when considered with some attention, and exclusively of private selfish feelings; whereas the pleasures of sympathy consist in doing good to others; those of ambition are scarce attainable in any great degree without this, or at least the appearance of it; and the pleasures of imagination are both capable of a very extensive communication, and most perfect when enjoyed in company.

Secondly, A regard to *self* frequently recurring must denominate a pleasure *selfish*; so that if any of the most generous pleasures, and such as at first view have no immediate relation to self-interest, be pursued in a cool, deliberate way, not from the influence of a present inclination, but the preconceived opinion, that it will afford pleasure, this is referred to self-interest. Now money has scarce any other relation to pleasure than that of an evident means; so that even after it has gained the power of pleasing instantaneously, the intermediate deliberate steps and associations must, however, frequently appear. It procures the other pleasures for us every day, after it has become pleasant in itself; and therefore must always be considered as a principal means. The other pleasures have, in general, a far greater share of indirect associations with previous pleasures, and acquire the power of gratifying, not so much from being manifest causes of other gratifications, as their most common adjuncts; whereas money is generally the most visible of all the causes. But honour, power, learning, and many other things, are pursued, in part, after the same manner, and for the same reasons,

as riches, viz. from a tacit supposition, that the acquisition of every degree of these is treasuring up a proportional degree of happiness, to be produced and enjoyed at pleasure. And the desires of each of these would in like manner increase perpetually during life, did they not curb one another by many mutual inconsistencies, or were not all damped by the frequent experience and recollection, that all the means of happiness cease to be so, when the body or mind cease to be disposed in a manner proper for the reception of happiness.

It is also worthy of observation, that riches, honours, power, learning, and all other things, that are considered as means of happiness, become means and ends to each other in a great variety of ways, thus transferring upon each other all the associated pleasures which they collect from different quarters, and approaching nearer and nearer perpetually to a perfect similarity and sameness with each other, in the instantaneous pleasures which they afford when pursued and obtained as ends.

It appears likewise, that all aggregates of pleasure, thus collected by them all, must, from the mechanism and necessity of our natures, and of the world which surrounds us, be made at last to centre and rest upon him who is the inexhaustible fountain of all power, knowledge, goodness, majesty, glory, property, &c. So that even avarice and ambition are, in their respective ways, carrying on the benevolent designs of him who is *all in all*. And the same thing may be hoped of every other passion and pursuit. One may hope, that they all agree and unite in leading to ultimate happiness and perfection. However, they differ greatly in their present consequences, and in their future ones, reaching to certain intervals of time indefinite and unknown to us, thus becoming good or evil, both naturally and morally, in respect of us, and our limited apprehensions, judgments, and anticipations.

ticipations. And yet one may humbly hope, as was said above, that every thing must be ultimately good, both naturally and morally.

OF REFINED SELF-INTEREST.

The second species of self-interest is that which I call refined self-interest. As the foregoing species is generated by an attention to, and frequent reflection upon, the things which procure us the pleasures of sensation, imagination, and ambition; and therefore cannot prevail in any great degree, till these pleasures have been generated, and prevailed for some time; so this species, or refined self-interest, which is a cool, deliberate seeking for ourselves the pleasures of sympathy, religion, and the moral sense, presupposes the generation of these pleasures, and the enjoyment of them for a sufficient time. And as some degree of gross self-interest is the natural and necessary consequence of the three first classes of pleasures, so is some degree of refined self-interest of the three last. A person who has had a sufficient experience of the pleasures of friendship, generosity, devotion, and self-approbation, cannot but desire to have a return of them, when he is not under the particular influence of any one of them, but merely on account of the pleasure which they have afforded; and will seek to excite these pleasures by the usual means, to treasure up to himself such means, keep himself always in a disposition to use them, &c. not at all from any particular vivid love of his neighbour, or of God, or from a sense of duty to him, but entirely from the view of private happiness. At least, there will be a great mixture of this refined self-interest in all the pleasures and duties of benevolence, piety, and the moral sense.

But then this refined self-interest is neither so common, nor so conspicuous in real life, as the gross
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one, since it rises late, is never of any great magnitude in the bulk of mankind, through their want of the previous pleasures of sympathy, religion, and the moral sense, in a sufficient degree, and in some it scarce prevails at all; whereas gross self-interest rises early in infancy, and arrives at a considerable magnitude before adult age. The detail of this second species of self-interest may be seen in books of practical religion.

OF RATIONAL SELF-INTEREST.

The third species of self-interest is the rational. This is the same thing with the abstract desire of happiness, and aversion to misery, which is supposed to attend every intelligent being during the whole course of his existence. I have already endeavoured to shew, that this supposition is not true in the proper sense of the words; and yet that very general desires do frequently recur to the mind, and may be excited by words and symbols of general import.

The hopes and fears relating to a future state, or to death, which is our entrance into it, are of this kind, and may be considered as proceeding from rational self-interest, in the highest and most abstracted sense that the terms admit of practically, since we have no definite knowledge of the nature and kind of the happiness or misery of another world. These hopes and fears are also the strongest of our selfish affections, and yet at the same time the chief foundation of the pure disinterested love of God, and of our neighbour, and the principal means of transferring our associations, so as that we may love and hate, pursue and fly, in the manner the best suited to our attainment of our greatest possible happiness. For hope, being itself a pleasure, may, by association, render indifferent, and even disagreeable, ob-

jects and actions, pleasant; and fear may make agreeable ones painful: hence we can either increase desires and aversions, that are suitable to our state or obliterate and convert them into their contraries, if they be unsuitable, by means of their connection with the hopes and fears of death, and a future state. I will therefore briefly state the rise and progress of these hopes and fears.

All our first associations with the idea of death are of the disgustful and alarming kind; and they are collected from all quarters, from the sensible pains of every sort, from the imperfection, weakness, loathsomeness, corruption, and disorder, where disease, old age, death animal or vegetable, prevail, in opposition to the beauty, order, and lustre of life, youth, and health; from the shame and contempt attending the first in many instances; whereas the last are honourable, as being sources of power and happiness, the reward of virtue, &c. and from the sympathetic passions in general. And it is necessary, that the heedlessness and inexperience of infancy and youth should be guarded by such terrors, and their headstrong appetites and passions curbed, that they may not be hurried into danger and destruction before they are aware. It is proper also, that they should form some expectations with respect to, and set some value upon, their future life in this world, that so they may be better qualified to act their parts in it, and make the quicker progress to perfection during their passage through it.

When children begin to have a sense of religion and duty formed in them, these do still farther heighten and increase the fear of death for the most part. For though there are rewards on the one hand, as well as punishments on the other; yet fear has got the start from the natural causes of it before-mentioned: and as pain is in general greater than pleasure, as was shewn above, from its consisting in stronger vibrations;

vibrations; so fear is in general more vivid than hope especially in children.

Moreover, the sensual and selfish appetites are the original of all the rest; yet these are sinful, and inconsistent with our own and other's happiness; they must therefore be restrained, and at last eradicated. But parents and governors, are, in this case, more apt to have recourse to fear, than to hope (in general, I suppose with reason, because hope is too feeble to withstand the violence of the natural appetites and passions). And it is to be added to all, that adults, by discovering, in general, much more of fear and sorrow in the apprehensions or prospect of death, than of hope and comfort, from the continuance of the causes just mentioned, propagate and increase the fear still farther in one another, and in children, infecting all around them, as is usual in other cases of the like kind. And by this means it comes to pass, that the fear of death does in some circumstances, particularly where the nervous system is, through a bodily disorder, reduced to an aptness to receive uneasy and disgustful vibrations, only or chiefly, being in a state of irritability approaching to pain, grow to a most enormous size, collecting and uniting every disagreeable idea and impression under the associations belonging to death; so that such persons live in perpetual anxiety and slavery to the fear of death. And where there is the consciousness of past guilt, or the want of an upright intention for the future, it rages with still greater fierceness, till these be removed entirely, or in part, by repentance and amendment.

It is farther to be observed, that the fear of death is much increased by the exquisiteness of the punishments threatened in a future state, and by the variety of the emblems, representations, analogies, and evidences, of natural and revealed religion, whereby all the terrors of all other things are transferred

upon these punishments; also by that peculiar circumstance of the eternity of them, which seems to have been a general tradition previous to the appearance of christianity, amongst both *Jews* and *Pagans*, and which has been the doctrine and opinion of the christian world ever since, some very few persons excepted. The consideration of any thing that is infinite, space, time, power, knowledge, goodness, perfection, &c. quite overpowers the faculties of the soul with wonder and astonishment: and when the peculiar feeling and concern belonging to *self* are applied here, and excited by the word *infinite*, by meditation, reading, &c. we must, and we ought to be alarmed to the full extent of our capacities. And the same conclusion follows, though we should suppose the punishments of a future state not to be absolutely and metaphysically infinite. For their great exquisiteness, and long duration, which are most clearly and plainly declared in the scriptures, make them practically so.

This is a brief sketch of the origin and progress of the fears attending the consideration of death, and a future state. We now come to inquire, how the hopes are generated.

First, then, We are to observe, that repentance, amendment, the consciousness of past virtue, and of good intentions for the future, give a title to the hopes and rewards of a future state; and that though while there are perpetual alternations of opposite consciousnesses, *i. e.* recollections and judgments on our own actions, the fear may prevail in general, both from the additional weight of the natural fear, and from the previous possession which the religious fear has obtained; yet by degrees the agreeable consciousness must prevail in those who are sincere (and sometimes it is to be feared a delusive one of the same kind in others), moderate the religious fear by little and little, and, in great measure, overcome the natural

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one; for which the way has been prepared from the superior strength of the religious fear, which has already obscured it in serious persons. And thus by degrees hope will begin to take place, as the general state of the mind, and the consideration of death, and a future state, become, for the most part, matter of joy and comfort.

Secondly, The deliverance from the fear of death adds greatly to this joy, in the same way as the removal of other pains is made the source of pleasure. And the returns of the fear of death at certain intervals, according to the state of our bodies or minds, and the moral qualities of our actions, will, if they be not too frequent, keep up this source of pleasure in the hope of futurity.

Thirdly, When the slavish fear of God is thus removed by faith and hope, all the pleasing sympathetic affections, such as love, gratitude, confidence, begin to exert themselves with respect to God, in a manner analogous, but a degree far superior to that in which they are exerted towards men. And it is easy to see how these, and such like causes concurring, may, in many cases, quite overcome the nature and religious fears of death and pain, and even make them acceptable.

COR. From hence we may pass to the fervours of devotion; these being chiefly the hopes, and pleasing affections, just spoken of, coalescing together so intimately by repeated associations, as that the separate parts there mentioned cannot be distinguished from each other in the compound. And as these fervours are themselves often esteemed a sign of holiness, and consequently a foundation of farther hope, they perpetuate and increase themselves for a certain time, *i. e.* till the new convert finds the reiterated appearance of the same ideas give less and less emotion and pleasure, just as in the other pleasures, sensible and intellectual; looks upon this as a mark of spiritual

desertion; finds numberless, unexpected, unthought-of, sins and imperfections, not yet subdued; falls into bodily disorders, from unseasonable severities, or spiritual intemperance, &c. and thus becomes dejected, scrupulous, and fearful.

By degrees the fears taken from death, and a future state, are confined to the mere apprehension of transgression, without any regard had to those, and even where they, when considered and expected, raise no fears.

However, all these things mortify pride, and the refined self-interest; lead, or even compel, men to resign all to God; and so advance them to a more pure, disinterested, and permanent love of God, and of their neighbour, than they could have arrived at (all other things remaining the same), had they not undergone these anxieties; and therefore are to be esteemed the kind corrections of an infinitely merciful Father.

S E C T. IV.

OF THE PLEASURES AND PAINS OF
SYMPATHY.

P R O P. XCVII.

*To examine how far the Pleasures and Pains of
Sympathy are agreeable to the foregoing Theory.*

THE sympathetic affections may be distinguished
into four classes, viz.

First, Those by which we rejoice at the happiness
of others.

Secondly, Those by which we grieve for their mi-
sery.

Thirdly, Those by which we rejoice at their
misery.

And, Fourthly, Those by which we grieve for their
happiness.

Of the first kind are sociality, good-will, genero-
sity and gratitude. Of the second, compassion and
mercy. Of the third, moroseness, anger, revenge,
jealousy, cruelty, and malice. And of the fourth,
emulation and envy.

It is easy to be conceived, that association should
produce affections of all these four kinds, since in
the intercourses of life the pleasures and pains of one
are, in various ways, intermixed with, and dependent
upon, those of others, so as to have clusters of their
miniatures excited, in all the possible ways in which
the happiness or misery of one can be combined with
the happiness or misery of another, *i. e.* in the four
above-mentioned. I will now enter upon the detail
of the rise and progress of each of them.

OF THE AFFECTIONS BY WHICH WE REJOICE
AT THE HAPPINESS OF OTHERS.

The first of these is sociality, or the pleasure which we take in the mere company and conversation of others, particularly of our friends and acquaintance, and which is attended with mutual affability, complaisance, and candour. Now most of the pleasures which children receive are conferred upon them by others, their parents, attendants, or play-fellows. And the number of the pleasures which they receive in this way, is far greater than that of the pains brought upon them by others. Indeed the hurts, and bodily injuries, which they meet with, are chiefly from themselves; and the denials of gratifications are either very few in number, or, if they be more frequent, give little uneasiness. It appears therefore, that, according to the doctrine of association, children ought to be pleased, in general, with the sight and company of all their acquaintance. And the same things, with some alterations hold in respect of adults, through the whole course, and general tenour of human life.

Besides the pleasures for which we are indebted to others, there are many which we enjoy in common with others, and in their company and conversation, and which therefore both enhance, and are enhanced by, the gaiety and happiness that appear in the countenances, gestures, words, and actions, of the whole company. Of this kind are the pleasures of feasting, sports and pastimes, rural scenes, polite arts, mirth, raillery, and ridicule, public shews, public rejoicings, &c. And in general it may be observed, that the causes of joy and grief are common to great numbers, affecting mankind according to the several divisions and subdivisions thereof into nations, ranks, offices, ages, sexes, families, &c.

And

And by all these things it comes to pass, that the face of an old acquaintance brings to view, as it were, the indistinct mixed recollection, the remaining vestiges of all the good and evil which we have felt, while his idea has been present with us.

The same observation may be made upon places; and particularly upon those where a man has spent his infancy and youth.

To all this it is to be added, that the rules of prudence, good manners, and religion, by restraining all rusticity, moroseness, and insolence, and obliging us to actions of a contrary nature, even though we have not the proper internal feelings, do by degrees contribute to beget these in us, *i. e.* to beget sociability and complaisance; just in the same manner, as a person in a passion becomes much more inflamed from his own angry expressions, gestures, and actions.

Good-will, or benevolence, when understood in a limited sense, may be termed that pleasing affection which engages us to promote the welfare of others to the best of our power. If it carry us so far as to forego great pleasures, or endure great pains it is called generosity. But good-will and benevolence, in a general sense, are put for all the sympathetic affections of the first and second class, viz. those by which we either rejoice in, and promote, the happiness of others, or grieve for, and endeavour to remove, their misery; as ill-will and malevolence, understood in a general sense also, are put for the contrary affections, viz. those of the third and fourth class.

Benevolence, in the limited sense, is nearly connected with sociality, and has the same sources. It has also a high degree of honour and esteem annexed to it, procures us many advantages, and returns of kindness, both from the person obliged and others; and is most closely connected with the hope of reward

reward in a future state, and with the pleasures of religion, and of self-approbation, or the moral sense. And the same things hold with respect to generosity in a much higher degree. It is easy therefore to see, how such associations may be formed in us, as to engage us to forego great pleasure, or endure great pain, for the sake of others; how these associations may be attended with so great a degree of pleasure as to over-rule the positive pain endured, or the negative one from the foregoing of a pleasure; and yet how there may be no direct, explicit expectation of reward, either from God or man, by natural consequence, or express appointment, not even of the concomitant pleasure which engages the agent to undertake the benevolent or generous action. And this I take to be a proof from the doctrine of association, that there is, and must be, such a thing as pure disinterested benevolence; also a just account of the origin and nature of it.

Gratitude includes benevolence, and therefore has the same sources with some additional ones; these last are the explicit or implicit recollection of the benefits and pleasures received, the hope of future ones, the approbation of the moral character of the benefactor, and the pleasures from the honour and esteem attending gratitude, much enhanced by the peculiar baseness and shamefulness of ingratitude.

OF THE AFFECTIONS BY WHICH WE GRIEVE FOR THE MISERY OF OTHERS.

Compassion is the uneasiness which a man feels at the misery of another. Now this in children seems to be grounded upon such associations as these that follow: the very appearance and idea of any kind of misery which they have experienced, or of any signs of distress which they understand, raise up in their nervous systems a state of misery from mere memory,

mory, on account of the strength of their imaginations; and because the connection between the adjuncts of pain, and the actual infliction of it, has not yet been sufficiently broken by experience, as in adults.

— When several children are educated together, the pains, the denials of pleasures, and the sorrows, which affect one, generally extend to all in some degree, often in an equal one. — When their parents, attendants, &c. are sick or afflicted, it is usual to raise in their minds the nascent ideas of pains and miseries, by such words and signs as are suited to their capacities; they also find themselves laid under many restraints on this account. — And when these and such like circumstances have raised the desires and endeavours to remove the causes of these their own internal uneasy feelings, or, which is the same thing, of these miseries of others (in all which they are much influenced, as in other like cases, by the great disposition to imitate, before spoken of); and a variety of internal feelings and desires of this kind are so blended and associated together, as that no part can be distinguished separately from the rest; the child may properly be said to have compassion.

The same sources of compassion remain, though with some alterations, during our whole progress through life; and an attentive person may plainly discern the constituent parts of his compassion, while they are yet the mere internal, and, as one may say, selfish feelings above-mentioned; and before they have put on the nature of compassion by coalescence with the rest.

Agreeably to this method of reasoning, it may be observed, that persons whose nerves are easily irritable, and those who have experienced great trials and afflictions, are, in general, more disposed to compassion than others; and that we are most apt to pity in those diseases and calamities, which we either have
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felt already, or apprehend ourselves in danger of feeling hereafter.

But adults have also many other sources of compassion, besides those already mentioned, and which differ according to their educations and situations in life. When love, natural affection, and friendship, have taught men to take a peculiar delight in certain objects, in mutual endearments, and familiar intercourses, those miseries affecting the beloved objects, which either totally destroy, or greatly interrupt, these intercourses, must give an exquisite uneasiness; and this uneasiness, by mixing itself with the other parts of our compassionate affections, will greatly increase the sum total in respect of these beloved objects.—A compassionate temper being great matter of praise to those who are endued with it, and the actions which flow from it being a duty incumbent on all, men are led to practise these actions, and to inculcate upon themselves the motives of compassion, by attending to distresses actually present, or described in history, real or fictitious.—The peculiar love and esteem which we bear to morally good characters, make us more sensibly touched with their miseries; which is farther augmented by our indignation, and want of compassion for morally ill characters, suffering the just punishment of their crimes. In like manner, the simplicity, the ignorance, the helplessness, and the many innocent diverting follies of young children, and of some brutes, lead men to pity them in a peculiar manner.

Mercy has the same general nature and sources as compassion, and seems to differ from it only in this, that the object of it has forfeited his title to happiness, or the removal of misery, by some demerit, particularly against ourselves. Here, therefore, resentment for an injury done to ourselves, or what is called a just indignation against vice in general, interferes, and checks the otherwise natural course of
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our compassion, so as, in the unmerciful, entirely to put a stop to it. But, in the merciful, the sources of compassion prevail over those of resentment and indignation; whence it appears, that the compassion required in acts of mercy, is greater than that in common acts of mere compassion: agreeably to which, it is observable, that mercy is held in higher esteem, than mere compassion.

OF THE AFFECTIONS BY WHICH WE REJOICE
AT THE MISERY OF OTHERS.

We come now to the affections of the third class, viz. moroseness, anger, revenge, jealousy, cruelty, and malice. Now moroseness, peevishness, severity, &c. are most apt to arise in those persons who have some real or imaginary superiority over others, from their rank, years, office, accomplishments, &c. which either magnifies the failures of duty in inferiors with respect to them, or engages them to be very attentive to these.—Bodily infirmities, and frequent disappointments, by making the common intercourse of life insipid, and enhancing small injuries; delicacy and effeminacy, by increasing the sensibility both of body and mind, with respect to pain and uneasiness; luxury, by begetting unnatural cravings, which clash not only with the like cravings of others, but also with the common course and conveniencies of human life; and, in short, all kinds of selfishness; have the same ill effect upon the temper.—The severe scrutiny which earnest penitents make into their own lives, during their novitiate, and the rigid censures which they pass upon their own actions, are often found, in proud and passionate tempers, to raise such indignation against vice, as breaks out into an undue severity of language and behaviour, in respect of others; and this especially, if they seem to themselves to have overcome all great
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vices, and are not yet arrived at a just sense of the many latent corruptions still remaining in them. And this is much increased by all opinions which represent the Deity as implacable towards a part of mankind, and this part as reprobate towards him. By all which we may see, that every thing which makes disagreeable impressions upon our minds at the same time that our fellow-creatures, or their ideas, are present with us; and especially if these be linked together in the way of cause and effect, or by any such relation; will, in fact, beget in us moroseness and peevishness. This follows from the doctrine of association; and is also an evident fact. It is likewise a strong argument for cheerfulness, and the pleasures of innocent moderate mirth.

Anger and cruelty are the opposites to mercy and compassion; the first, as a sudden start of passion, by which men wish and endeavour harm to others, and rejoice in it when done; which is revenge: the latter as a more settled habit of mind, disposing men to take a delight in inflicting misery and punishment, and in satiating their thirst after these, by beholding the tortures and anguish of the sufferers.

Anger and revenge may be analysed as follows. The appearance, idea, approach, actual attack, &c. of any thing from which a child has received harm, must raise in his mind, by the law of association, a miniature trace of that harm. The same harm often arises from different causes, and different harms from the same cause: these harms and causes have an affinity with each other: and thus they are variously mixed and connected together; so as that a general confused idea of harm, with the uneasy state of the nervous system, and the consequent activity of the parts, are raised up in young children upon certain appearances and circumstances. By degrees the denial of gratifications, and many intellectual aggregates,

gates, with all the signs and tokens of these, raise up a like uneasiness, in the manner before explained. And thus it happens, that when any harm has been received, any gratification denied, or other mental uneasiness occasioned, a long train of associated remainders of painful impressions enhance the displeasure, and continue it much beyond its natural period. This is the nascent state of the passion of anger, in which it is nearly allied to fear, being the continuance of the same internal feelings, quickened, on one hand, by the actual, painful, or uneasy impression, but moderated on the other by the absence of the apprehension of future danger.

By degrees the child learns, from observation and imitation, to use various muscular exertions, words, gestures, &c. in order to ward off or remove the causes of uneasiness or pain, so as to strike, talk loud, threaten, &c. and so goes on multiplying perpetually, by farther and farther associations, both the occasions of anger, and the expressions of it; and particularly associates a desire of hurting another with the apprehension, or the actual receiving, of harm from that other.

As men grow up to adult age, and distinguish living creatures from things inanimate, rational and moral agents from irrational ones, they learn to refer effects to their ultimate causes; and to consider all the intermediate ones as being themselves effects, depending on the ultimate cause. And thus their resentment passes from the inanimate instrument to the living agent; and more especially, if the living agent be a rational and moral one. For, First, Living rational agents are alone capable of being restrained by threatenings and punishments from committing the injurious action. All our expressions of anger must therefore be directed against them.—Secondly, Inanimate things are incapable of feeling the harms which anger wishes: the desire of revenge must therefore

therefore be entirely confined to animals. And these two things have great influence on each other. Our threatening harm merely from a motive of security, leads us to wish it really; wishing it leads us to threaten and inflict it, where it can afford no security or advantage to us.—Thirdly, As we improve in observation and experience, and in the faculty of analysing the actions of animals, we perceive that brutes and children, and even adults in certain circumstances, have little or no share in the actions referred to them; but are themselves under the influence of other causes, which therefore are to be deemed the ultimate ones. Hence, our resentment against them must be much abated in these cases, and transferred to the ultimate living cause, usually called the free agent, if so be that we are able to discover him.—Lastly, when the moral ideas of just and unjust, right and wrong, merit and demerit, have been acquired, and applied to the actions and circumstances of human life in the manner to be hereafter described, the internal feelings of this class, *i. e.* the complacency and approbation attending the first, the disgust, disapprobation, and even abhorrence, attending the last, have great influence in moderating or increasing our resentment. The associations of the first kind are at utter variance with those suggested by the sense of pain; of the last, coincide with and strengthen it. And as the rectitude of the moral sense is the highest matter of encomium, men are ashamed not to be thought to submit all their private feelings to its superior authority, and acquiesce in its determinations. And thus, by degrees, all anger and resentment in theory, all that even ill men will attempt to justify, is confined to injury, to sufferings which are not deserved, or which are inflicted by a person who has no right to do it. And this at last makes it so in fact, to a great degree, amongst those who are much influenced by their own moral sense,
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or by that of others. Yet still, as a confirmation of the foregoing doctrine, it is easy to observe, that many persons are apt to be offended even with stocks and stones, with brutes, with hurts merely accidental and undesigned, and with punishments acknowledged to be justly inflicted; and this in various degrees, according to the various natural and acquired dispositions of their minds.

Cruelty and malice are considered, not as passions of the mind, but as habits, as the deliberate wishing of misery to others, delighting in the view and actual infliction of it, and this without the consideration of injury received or intended. However, it will easily appear, that they are the genuine and necessary offspring of anger indulged and gratified. They are most apt to arise in proud, selfish, and timorous persons, those who conceive highly of their own merits, and of the consequent injustice of all offences against them; and who have an exquisite feeling and apprehension, in respect of private gratifications and uneasinesses. The low and unhappy condition of those around a man gives a dignity to his own; and the infliction of punishment, or mere suffering, strikes a terror, and so affords security and authority. Add to these, the pleasures arising from gratifying the will before explained, and perhaps some from mere curiosity, and the rousing an obdurate callous mind to a state of sensibility. Thus we may perceive how nearly one ill passion is related to another; and that it is possible for men to arrive at last at some degree of pure disinterested cruelty and malice.

The jealousy against a rival in the affections of a beloved person of the other sex; also that peculiar resentment against this beloved person, when suspected to be unfaithful, which goes by the same name; are easily deducible from their sources, in the manner so often repeated. And it is owing to the extraordinary magnitude of the passions and pleasures between

the sexes, and the singular contempt and ridicule thrown upon the person despised and deceived (the last of which springs from the first), that these two sorts of jealousy rise to such a height. This is more peculiarly remarkable in the southern climates, where the passions between the sexes are more violent than amongst us. The nature and origin of jealousies and suspicions of other kinds, with the affections attending them, may easily be understood from what has been already advanced.

OF THE AFFECTIONS BY WHICH WE GRIEVE FOR
THE HAPPINESS OF OTHERS.

Emulation and envy make the fourth class of the sympathetic affections. These are founded in the desire of pleasures, honours, riches, power, &c. and the consequent engrossing what others desire, losing what they obtain, in a comparison of our own acquisitions with those of others, &c. by which the happiness of others is connected with our misery; so that at last we become uneasy at their happiness, even where there is no such connection, *i. e.* emulate and envy where our own interest is no ways concerned.

Having now seen, in some measure, the nature and origin of the principal sympathetic affections, pleasing and tormenting, moral and immoral, let us consider the several objects upon which these various and contrary affections are exerted.

I begin with the most intimate of all the relations of life; that of husband and wife. Where this union is cemented by the several pleasures of sensation and imagination before-mentioned, also by those of the moral and religious kinds hereafter to be described, love, generosity, gratitude, compassion, and all the affections of the first and second class, prevail in the highest degree possible, to the exclusion of all those of the third and fourth class; so that the marriage-state, in these cases, affords the most perfect
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earnest and pattern, of which our imperfect condition here admits, of the future happiness of the good in another world. And it is remarkable, that this state is in scripture made the emblem of future happiness, and of the union of Christ with the church.

Where the ties of affection are weaker, and particularly where there is a great deficiency in the moral or religious dispositions of either or both the parties, the passions of the third class intermix themselves with those of the first and second; and, in many cases, the opposite affections prevail in great degrees alternately, and even at short and frequent intervals. And indeed each kind often becomes more violent from succeeding its opposite.

In very immoral and wicked persons the passions of the third class prevail almost entirely, and that especially where the peculiar affection, called love by young persons, and which springs from the pleasures of sensation, imagination, and ambition, in the manner above explained, was originally weak.

The affection of parents towards children seems to begin from the pain which the mother feels in bringing them into the world, and the sympathetic fears and cares of the father in consequence thereof, and in some degree from children's being supposed to belong to their parents in a very peculiar sense, and being parts of their own bodies. It is increased, especially in mothers, by all the signs of life, sense, and distress, which the helpless tender infant shews; many religious and moral considerations, with the language in which these are expressed, adding also great force thereto. The giving suck in the mother, with all the fears and cares in both parents, increases it still farther; and as the child advances in age and understanding, diverts by his little follies, pleases by his natural beauty, draws on the encomiums of others, surprises by his agility or wit, &c. the affections continue to rise. When the time comes for the cultivation

vation of the moral and religious powers of the mind, these either increase the affection by their proper appearance and growth, or check it by being deficient, and by giving occasion to censures and corrections. Yet even these last, when justly proportioned, and followed by mental improvement, add greatly to the warmth of affection by raising compassion. And thus the remainders of former affections, and the accessions of new ones, seem to make a sum total, which grows perpetually greater in tender and religious parents.

The little affection commonly shewn to bastards agrees very well with the foregoing history of parental affection.

The affection towards grand-children is, in general, the same as that towards children, differing chiefly in this, that it is more fond and tender, and less mixed with severity, and the necessary corrections. This may be, perhaps, because the appearance of the helpless infant, after so long an interval, raises up all the old traces of parental affection with new vigour, from their not having been exerted for some years, and by recalling many of the most moving scenes of the foregoing life; so that these old traces, increased by the addition of new familiar ones, make together a greater sum total than before: or, perhaps, because old persons have more experience of pain, sorrow, and infirmity; and so are more disposed to compassion, in the same manner as they are more apt to weep; and because they excuse themselves from the uneasy task of censuring and reproving.

The affections of children towards their parents are founded in the many pleasures which they receive from them, or in their company. These affections are afterwards increased by their improvement in morality and religion, and by the several common causes of good-will, gratitude, compassion, &c. prevailing

vailing here with peculiar force. It seems, however, that the sources of this affection are fewer and weaker than the sources of that towards children; and it is observed in fact, that the affection of children is in general weaker than that of parents. For which also an evident final cause may be assigned. It is to be added farther, that the many engagements and distractions, which lay hold of the opening faculties of young persons, upon their entrance into life, have a principal share in this effect.

Friendship, with the bitter enmities that sometimes succeed the breaches of it, and the emulation and envy that are apt to arise in friends, from the equality and similarity of their circumstances, may be easily understood from what has been delivered already.

In like manner we may explain the affections between persons of the same family, brothers, cousins, &c. of the same age, sex, district, education, temper, profession, &c.

By all these artificial ties our good-will and compassion are perpetually extended more and more, growing also perpetually weaker and weaker, in proportion to their diffusion. Yet still the common blessings and calamities, which fall upon whole nations and communities; the general resemblance of the circumstances of all mankind to each other, in their passage through life; their common relation to God as their creator, governor, and father; their common concern in a future life, and in the religion of Christ, &c. are capable of raising strong sympathetic affections towards all mankind, and the several larger divisions of it, in persons of religious dispositions, who duly attend to these things. In like manner the opinions of savageness, barbarity, and cruelty, which ignorant and unexperienced persons are apt to entertain, concerning some distant nations, raise up in their minds some degrees of general dislike, aversion, and hatred.

S E C T. V.

OF THE PLEASURES AND PAINS OF THEOPATHY.

P R O P. XCVIII.

To examine how far the Pleasures and Pains of Theopathy are agreeable to the foregoing Theory.

UNDER this class I comprehend all those pleasures and pains, which the contemplation of God, and his attributes, and of our relation to him, raises up in the minds of different persons, or in that of the same person at different times. And in order to speak with more precision concerning this class of affections, and to deduce them more readily from the theory of these papers, it will be proper first to inquire into the idea of God, as it is found in fact amongst men, particularly amongst *Jews* and *Christians*, *i. e.* to inquire what associations may be observed in fact to be heaped upon, and concur in this word, and the equivalent and related terms and phrases.

First, then, It is probable, that, since many actions and attributes belonging to men are, and indeed must be, in common language, applied to God, children, in their first attempts to decypher the word God, will suppose it to stand for a man, whom they have never seen, and of whom consequently they form a compound fictitious idea, consisting of parts before generated by men, whom they have seen.

Secondly, When they hear or read, that God resides in heaven (*i. e.* according to their conceptions,
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in the sky, amongst the stars), that he made all things, that he sees, hears, and knows all things, can do all things, &c. with the many particular modes of expression that are comprehended under these general ones, vivid ideas, which surprize and agitate the mind (lying upon the confines of pain), are raised in it; and if they be so far advanced in understanding, as to be affected with apparent inconsistencies and impossibilities in their ideas, they must feel great perplexity of imagination, when they endeavour to conceive and form definite ideas agreeable to the language of this kind, which they hear and read. Now this perplexity will add to the vividness of the ideas, and all together will transfer upon the word God, and its equivalents, such secondary ideas, as may be referred to the heads of magnificence, astonishment, and reverence.

Thirdly, When children hear that God cannot be seen, having no visible shape, no parts; but that he is a spiritual infinite being; this adds much to their perplexity and astonishment, and by degrees destroys the association of the fictitious visible idea before-mentioned with the word God. However, it is probable, that some visible ideas, such as those of the heavens, a fictitious throne placed there, a multitude of angels, &c. still continue to be excited by the word God, and its equivalents, when dwelt upon in the mind.

Fourthly, When the child hears, that God is the rewarder of good actions, and the punisher of evil ones, and that the most exquisite future happiness or misery (described by a great variety of particulars and emblems) are prepared by him for the good and bad respectively; he feels strong hopes and fears rise alternately in his mind, according to the judgment which he passes upon his own actions, founded partly upon the previous judgment of others, partly

upon an imperfect moral sense begun to be generated in him.

And laying all these things together it will appear, that amongst *Jews* and *Christians*, children begin probably with a definite visible idea of God; but that by degrees this is quite obliterated, without any thing of a stable precise nature succeeding in its room; and that, by farther degrees, a great variety of strong secondary ideas, *i. e.* mental affections (attended indeed by visible ideas, to which proper words are affixed, as of angels, the general judgment, &c.) recur in their turns, when they think upon God, *i. e.* when this word, or any of its equivalents, or any equivalent phrase or symbol, strike the mind strongly, so that it dwells upon them for a sufficient time, and is affected by them in a sufficient degree.

Amongst heathen nations, where idolatry and polytheism prevail, the case is different; but this difference may easily be understood by applying the foregoing method of reasoning to the circumstances of the heathen world.

I will now inquire more particularly into the nature and origin of the affections exerted towards God. They may be ranked under two general heads, love and fear; agreeably to the general division of the sympathetic affections into benevolence and malevolence. However, the analogy here is not a complete one, as will be seen presently.

To the love of God may be referred gratitude, confidence and resignation; also enthusiasm, which may be considered as a degeneration of it. To the fear, reverence (which is a mixture of love and fear); also superstition and atheism, which are degenerations of the fear of God,

OF THE LOVE OF GOD.

The love of God, with its associates, gratitude, confidence and resignation, is generated by the contemplation of his bounty and benignity to us, and to all his creatures, as these appear from the view of the natural world, the declarations of the scriptures, or a man's own observation and experience in respect of the events of life. It is supported, and much increased, by the consciousness of upright intentions, and sincere endeavours, with the consequent hope of a future reward, and by prayer, vocal and mental, public and private, inasmuch as this gives a reality and force to all the secondary ideas before spoken of. Frequent conversation with devout persons, and frequent reading of devout books, have great efficacy also, from the infectiousness of our tempers and dispositions, and from the perpetual recurrency of the proper words, and of their secondary ideas; first in a faint state, afterwards in a stronger and stronger perpetually. The contemplation of the rest of the divine attributes, his omnipotence, omniscience, eternity, ubiquity, &c. have also a tendency to support and augment the love of God, when this is so far advanced, as to be superior to the fear; till that time these wonderful attributes enhance the fear so much, as to check the rise and growth of the love for a time. Even the fear itself contributes to the generation and augmentation of the love in an eminent degree, and in a manner greatly analogous to the production of other pleasures from pains. And indeed it seems, that, notwithstanding the variety of ways above-mentioned, in which the love of God is generated, and the consequent variety of the intellectual aggregates, and secondary ideas, there must be so great a resemblance amongst them, that they cannot but languish by frequent recurrency, till such time

time as ideas of an opposite nature, by intervening at certain seasons, give them new life.

The love of God is, according to this theory, evidently deduced in part from interested motives directly, viz. from the hopes of a future reward; and those motives to it, or sources of it, in which direct explicit self-interest does not appear, may yet be analysed up to it ultimately. However, after all the several sources of the love of God have coalesced together, this affection becomes as disinterested as any other; as the pleasure we take in any natural or artificial beauty, in the esteem of others, or even in sensual gratifications.

It appears also, that this pure disinterested love of God may, by the concurrence of a sufficient number of sufficiently strong associations, arise to such a height, as to prevail over any of the other desires interested or disinterested; for all, except the sensual ones, are of a factitious nature, as well as the love of God; and the sensual ones are, in our progress through life, overpowered by them all in their respective turns.

Euthusiasm may be defined a mistaken persuasion in any person, that he is a peculiar favourite with God; and that he receives supernatural marks thereof. The vividness of the ideas of this class easily generates this false persuasion in persons of strong fancies, little experience in divine things, and narrow understandings (and especially where the moral sense, and the scrupulosity attending its growth and improvement, are but imperfectly formed), by giving a reality and certainty to all the reveries of a man's own mind, and cementing the associations in a preternatural manner. It may also be easily contracted by contagion, as daily experience shews; and indeed more easily than most other dispositions from the glaring language used by enthusiasts, and from the
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the great flattery and support, which enthusiasm affords to pride and self-conceit.

OF THE FEAR OF GOD.

The fear of God arises from a view of the evils of life, from the threatenings of the scriptures, from the sense of guilt, from the infinity of all God's attributes, from prayer, meditation, reading, and conversation upon these and such like subjects, in a manner analogous to the love of God. When confined within certain limits, and especially when tempered with love, so as to become awe, veneration and reverence, it remains in a natural state, *i. e.* suits our other circumstances; and, as before observed, has a considerable share in generating the love of God. When excessive, or not duly regarded, it degenerates either into superstition or atheism.

Superstition may be defined a mistaken opinion concerning the severity and punishments of God, magnifying these in respect of ourselves or others. It may arise from a sense of guilt, from bodily indisposition, from erroneous reasoning, &c. That which arises from the first cause has a tendency to remove itself by regulating the person's behaviour, and consequently lessening his sense of guilt. The other kinds often increase for a time, come to their height at last, and then decline again. They do also, in some cases, increase without limits during life. All kinds of superstition have been productive of great absurdities in divine worship, both amongst *Pagans*, and amongst *Jews* and *Christians*; and they have all a great tendency to sour the mind, to check natural benevolence and compassion, and to generate a bitter persecuting spirit. All which is much augmented where superstition and enthusiasm pass alternately into each other at intervals; which is no uncommon case.

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Under atheism I here comprehend not only the speculative kind, but the practical, or that neglect of God, where the person thinks of him seldom, and with reluctance, and pays little or no regard to him in his actions, though he does not deny him in words. Both kinds seem in christian countries, where reasonable satisfaction in religious matters is easy to be had by all well-disposed minds, and gross ignorance uncommon except in ill-disposed ones, to proceed from an explicit or implicit sense of guilt, and a consequent fear of God, sufficient to generate an aversion to the thoughts of him, and to the methods by which the love might be generated, and yet too feeble to restrain from guilt; so that they may properly be considered as degenerations of the fear of God. What has been delivered already in these papers, concerning the connection of fear, aversion, and the other uneasy passions, with each other, and also of the tendency of all pain to prevent the recurrency of the circumstances, by which it is introduced, may afford some light here.

It appears upon the whole, that the theopathic affections are, in some things, analogous to the sympathetic ones, as well as different in others; and that this difference arises chiefly from the infinity and absolute perfection of the divine nature.

Affections of an intermediate kind are generated in respect of good and evil beings of an invisible nature, and of an order superior to us (such as angels and devils); whose origin and growth will easily be understood from what is here delivered.

S E C T. VI.

OF THE PLEASURES AND PAINS OF THE
MORAL SENSE.

P R O P. XCIX.

To examine how far the Pleasures and Pains of the moral Sense are agreeable to the foregoing Theory.

THERE are certain tempers of mind, with the actions flowing from them, as of piety, humility, resignation, gratitude, &c. towards God; of benevolence, charity, generosity, compassion, humility, gratitude, &c. towards men; of temperance, patience, contentment, &c. in respect of a person's own private enjoyments or sufferings; which when he believes himself to be possessed of, and reflects upon, a pleasing consciousness and self-approbation rise up in his mind, exclusively of any direct explicit consideration of advantage likely to accrue to himself, from his possession of these good qualities. In like manner the view of them in others raises up a disinterested love and esteem for those others. And the opposite qualities of impiety, profaneness, uncharitableness, resentment, cruelty, envy, ingratitude, intemperance, lewdness, selfishness, &c. are attended with the condemnation both of ourselves and others. This is, in general, the state of the case; but there are many particular differences, according to the particular education, temper, profession, sex, &c. of each person.

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Or, which is the same thing, the secondary ideas belonging to virtue and vice, duty and sin, innocence and guilt, merit and demerit, right and wrong, moral good and moral evil, just and unjust, fit and unfit, obligation and prohibition, &c. in one man, bear a great resemblance to those belonging to the same words in another, or to the corresponding words, if they have different languages; and yet do not exactly coincide, but differ more or less, according to the difference in education, temper, &c.

Now both this general resemblance, and these particular differences, in our ideas, and consequent approbation or disapprobation, seem to admit of an analysis and explanation from the following particulars.

First, Children are, for the most part, instructed in the difference and opposition between virtue and vice, duty and sin, &c. and have some general descriptions of the virtues and vices inculcated upon them. They are told, that the first are good, pleasant, beautiful, noble, fit, worthy of praise and reward, &c. the last odious, painful, shameful, worthy of punishment, &c. so that the pleasing and displeasing associations, previously annexed to these words in their minds, are, by means of that confidence which they place in their superiors, transferred upon the virtues and vices respectively. And the mutual intercourses of life have the same effect in a less degree, with respect to adults, and those children who receive little or no instruction from their parents or superiors. Virtue is in general approved, and set off by all the encomiums, and honourable appellations, that any other thing admits of, and vice loaded with censures and reproaches of all kinds, in all good conversation and books. And this happens oftener than the contrary, even in bad ones; so that as far as men are influenced in their judgments by those of others, the balance is, upon the whole, on the side of virtue.

Secondly,

Secondly, There are many immediate good consequences, which attend upon virtue, as many ill ones do upon vice, and that during our whole progress through life. Sensuality and intemperance subject men to diseases and pain, to shame, deformity, filthiness, terrors, and anxieties; whereas temperance is attended with ease of body, freedom of spirits, the capacity of being pleased with the objects of pleasure, the good opinion of others, the perfection of the senses, and of the faculties bodily and mental, long life, plenty, &c. Anger, malice, envy, bring upon us the returns of anger, malice, envy, from others, with injuries, reproaches, fears, and perpetual disquietude; and in like manner good-will, generosity, compassion, are rewarded with returns of the same, with the pleasures of sociality and friendship, with good offices, and with the highest encomiums. And when a person becomes properly qualified by the previous love of his neighbour to love God, to hope and trust in him, and to worship him in any measure as he ought to do, this affords the sincerest joy and comfort; as, on the contrary, the neglect of God, or practical atheism, the murmuring against the course of Providence, sceptical unsettledness, and fool-hardy impiety, are evidently attended with great anxieties, gloominess, and distraction, as long as there are any traces of morality or religion left upon men's minds. Now these pleasures and pains, by often recurring in various combinations, and by being variously transferred upon each other, from the great affinity between the several virtues, and their rewards, with each other; also between the several vices, and their punishments, with each other; will at last beget in us a general, mixed, pleasing idea and consciousness, when we reflect upon our own virtuous affections or actions; a sense of guilt, and an anxiety, when we reflect on the contrary;

trary; and also raise in us the love and esteem of virtue, and the hatred of vice in others.

Thirdly, The many benefits which we receive immediately from, or which have some evident, though distant, connection with the piety, benevolence, and temperance of others; also the contrary mischiefs from their vices; lead us first to the love and hatred of the persons themselves by association, as explained under the head of sympathy, and then by farther associations to the love and hatred of the virtues and vices, considered abstractedly, and without any regard to our own interest; and that whether we view them in ourselves or others. As our love and esteem for virtue in others is much increased by the pleasing consciousness, which our own practice of it affords to ourselves, so the pleasure of this consciousness is much increased by our love of virtue in others.

Fourthly, The great suitableness of all the virtues to each other, and to the beauty, order, and perfection of the world, animate and inanimate, impresses a very lovely character upon virtue; and the contrary self-contradiction, deformity, and mischievous tendency of vice, render it odious, and matter of abhorrence to all persons that reflect upon these things; and beget a language of this kind, which is borrowed, in great measure, from the pleasures and pains of imagination, and applied with a peculiar force and fitness to this subject from its great importance.

Fifthly, The hopes and fears which arise from the consideration of a future state, are themselves pleasures and pains of a high nature. When therefore a sufficient foundation has been laid by a practical belief of religion, natural and revealed, by the frequent view of, and meditation upon, death, by the loss of departed friends, by bodily pains, by worldly disappointments and afflictions, for forming strong associations of the pleasures of these hopes with duty, and the pains of these fears with sin, the
reiterated

reiterated impressions of those associations will at last make duty itself a pleasure, and convert sin into a pain, giving a lustre and deformity respectively to all their appellations; and that without any express recollection of the hopes and fears of another world, just as in other cases of association.

Sixthly, All meditations upon God, who is the inexhaustible fountain, and infinite abyss, of all perfection, both natural and moral; also all the kinds of prayer, *i. e.* all the ways of expressing our love, hope, trust, resignation, gratitude, reverence, fear, desire, &c. towards him; transfer by association, all the perfection, greatness, and gloriousness of his natural attributes upon his moral ones, *i. e.* upon moral rectitude. We shall by this means learn to be merciful, holy, and perfect, because God is so; and to love mercy, holiness, and perfection, wherever we see them.

And thus we may perceive, that all the pleasures and pains of sensation, imagination, ambition, self-interest, sympathy, and theopathy, as far as they are consistent with one another, with the frame of our natures, and with the course of the world, beget in us a moral sense, and lead us to the love and approbation of virtue, and to the fear, hatred, and abhorrence of vice. This moral sense therefore carries its own authority with it, inasmuch as it is the sum total of all the rest, and the ultimate result from them; and employs the force and authority of the whole nature of man against any particular part of it, that rebels against the determinations and commands of the conscience or moral judgment.

It appears also, that the moral sense carries us perpetually to the pure love of God, as our highest and ultimate perfection, our end, centre, and only resting-place, to which yet we can never attain.

When the moral sense is advanced to considerable perfection, a person may be made to love and hate,

merely because he ought, *i. e.* the pleasures of moral beauty and rectitude, and the pains of moral deformity and unfitness, may be transferred, and made to coalesce almost instantaneously.

Scrupulosity may be considered as a degeneration of the moral sense, resembling that by which the fear of God passes into superstition; for it arises, like this, from a consciousness of guilt, explicit or implicit, from bodily indisposition, and from an erroneous method of reasoning. It has also a most intimate connection with superstition (just as moral rectitude has with the true love and fear of God); and, like superstition, it is, in many cases, observed to work its own cure by rectifying what is amiss; and so by degrees removing both the explicit and implicit consciousness of guilt. It seems also, that in this imperfect state men seldom arrive at any great degree of correctness in their actions without some previous scrupulosity, by which they may be led to estimate the nature and consequences of affections and actions with care, impartiality and exactness.

The moral sense or judgment here spoken of, is sometimes considered as an instinct, sometimes as determinations of the mind, grounded on the eternal reasons and relations of things. Those who maintain either of these opinions may, perhaps, explain them so as to be consistent with the foregoing analysis of the moral sense from association. But if by instinct be meant a disposition communicated to the brain, and in consequence of this, to the mind, or to the mind alone, so as to be quite independent of association; and by a moral instinct, such a disposition producing in us moral judgments concerning affections and actions; it will be necessary, in order to support the opinion of a moral instinct, to produce instances, where moral judgments arise in us independently of prior associations determining thereto.

In like manner, if by founding the morality of actions, and our judgment concerning this morality, on the eternal reasons and relations of things be meant, that the reasons drawn from the relations of things, by which the morality or immorality of certain actions is commonly proved, and which, with the relations, are called eternal, from their appearing the same, or nearly the same, to the mind at all times, would determine the mind to form the corresponding moral judgment independently of prior associations, this ought also to be proved by the allegation of proper instances. To me it appears, that the instances are, as far as we can judge of them, of an opposite nature, and favour the deduction of all our moral judgments, approbations, and disapprobations, from association alone. However, some associations are formed so early, repeated so often, riveted so strong, and have so close a connection with the common nature of man, and the events of life which happen to all, as in a popular way of speaking, to claim the appellation of original and natural dispositions; and to appear like instincts, when compared with dispositions evidently factitious; also like axioms, and intuitive propositions, eternally true according to the usual phrase, when compared with moral reasonings of a compound kind. But I have endeavoured to shew in these papers, that all reasoning, as well as affection, is the mere result of association.

C O N C L U S I O N ;

CONTAINING SOME REMARKS ON THE

MECHANISM OF THE HUMAN MIND.

BESIDES the consequences flowing from the doctrine of association, which are delivered in the Corollaries to the fourteenth Proposition, there is another, which is thought by many to have a pernicious tendency in respect of morality and religion; and which therefore it will be proper that I should consider particularly.

The consequence I mean is that of the mechanism or necessity of human actions, in opposition to what is generally termed free-will. Here then I will,

First, State my notion of the mechanism or necessity of human actions.

Secondly, Give such reasons as induce me to embrace the opinion of the mechanism of human actions.

Thirdly, Consider the objections and difficulties attending this opinion.

And, lastly, Allege some presumptions in favour of it from its consequences.

By the mechanism of human actions I mean, that each action results from the previous circumstances of body and mind, in the same manner, and with the same certainty, as other effects do from their mechanical causes; so that a person cannot do indifferently either of the actions *A*, and its contrary *a*, while the previous circumstances are the same; but is under an absolute necessity of doing one of them, and that only. Agreeably to this I suppose, that by free-will is meant a power of doing either the action, *A*, or

A, or its contrary *a*; while the previous circumstances remain the same.

If by free-will be meant a power of beginning motion, this will come to the same thing; since, according to the opinion of mechanism, as here explained, man has no such power; but every action, or bodily motion, arises from previous circumstances, or bodily motions, already existing in the brain, *i. e.* from vibrations, which are either the immediate effect of impressions then made, or the remote compound effect of former impressions, or both.

But if by free-will be meant any thing different from these two definitions of it, it may not perhaps be inconsistent with the mechanism of the mind here laid down. Thus, if free-will be defined the power of doing what a person desires or wills to do, of deliberating, suspending, choosing, &c. or of resisting the motives of sensuality, ambition, resentment, &c. Free-will, under certain limitations, is not only consistent with the doctrine of mechanism, but even flows from it; since it appears from the foregoing theory, that voluntary and semivoluntary powers of calling up ideas, of exciting and restraining affections, and of performing and suspending actions, arise from the mechanism of our natures. This may be called free-will in the popular and practical sense, in contradistinction to that, which is opposed to mechanism, and which may be called free-will in the philosophical sense.

I proceed now to the arguments which favour the opinion of mechanism.

First, then, It is evident to, and allowed by all, that the actions of mankind proceed, in many cases, from motives, *i. e.* from the influence which the pleasures and pains of sensation, imagination, ambition, self-interest, sympathy, theopathy, and the moral sense, have over them. And these motives seem to act like all other causes. When the motive is strong, the action is performed with vigour; when weak,

feebly. When a contrary motive intervenes, it checks or over-rules, in proportion to its relative strength, as far as one can judge. So that where the motives are the same, the actions cannot be different; where the motives are different, the actions cannot be the same. And it is matter of common observation, that this is the case in fact, in the principal actions of life, and such where the motives are of a magnitude sufficient to be evident. It is reasonable therefore to interpret the obscure cases by the evident ones; and to infer, that there are in all instances motives of a proper kind and degree, which generate each action; though they are sometimes not seen through their minuteness, or through the inattention or ignorance of the observer. Agreeably to which those persons, who study the causes and motives of human actions, may decypher them much more completely, both in themselves, and those with whom they converse, than others can.

Suppose now a person able to decypher all his own actions in this way, so as to shew that they corresponded in kind and degree to the motives arising from the seven classes of pleasures and pains considered in this theory; also able to decypher the principal actions of others in the same way: this would be as good evidence, that motives were the mechanical causes of actions, as natural phænomena are for the mechanical operation of heat, diet, or medicines. Or if he could not proceed so far, but was able only to decypher most of his own actions, and many of the principal ones of others, still the evidence would scarce be diminished thereby, if the deficiency was no more than is reasonably to be expected from our ignorance and inattention, in respect of ourselves and others. Let the reader make the trial, especially upon himself, since such a self-examination cannot but be profitable, and may perhaps be pleasant; and that either according to the seven classes of pleasures and pains here laid down, or any other division,

division, and judge as he thinks fit upon mature deliberation.

It may be of use in such an inquiry into a man's self, as I here propose, for him to consider in a short time after any material action is past, whether, if he was once more put into the same rigidly exact circumstances, he could possibly do otherwise than as he did. Here the power of imagination will intervene, and be apt to deceive the inquirer, unless he be cautious. For in this review other motives, besides those which did actually influence him, will start up; and that especially if the action be such as he wishes to have been performed with more vigour or less, or not to have been performed at all. But when these foreign motives are set aside, and the imagination confined to those which did in fact take place, it will appear impossible, as it seems to me, that the person should have done otherwise than the very thing which he did.

Secondly, According to the theory here laid down, all human actions proceed from vibrations in the nerves of the muscles, and these from others, which are either evidently of a mechanical nature, as in the automatic motions; or else have been shewn to be so in the account given of the voluntary motions:

And if the doctrine of vibrations be rejected, and sensation and muscular motion be supposed to be performed by some other kind of motion in the nervous parts, still it seems probable, that the same method of reasoning might be applied to this other kind of motion.

Lastly, To suppose, that the action *A*, or its contrary *a*, can equally follow previous circumstances, that are exactly the same, appears to me the same thing, as affirming that one or both of them might start up into being without any cause; which, if admitted, appears to me to destroy the foundation of all general abstract reasoning; and particularly of that whereby the existence of the first cause is proved.

One of the principal objections to the opinion of mechanism is that deduced from the existence of the moral sense, whose history I have just given. But it appears from that history, that God has so formed the world, and perhaps (with reverence be it spoken) was obliged by his moral perfections so to form it, as that virtue must have amiable and pleasing ideas affixed to it; vice, odious ones. The moral sense is therefore generated necessarily and mechanically. And it remains to be inquired, whether the amiable and odious ideas above shewed to be necessarily affixed to virtue and vice respectively, though differently according to the different events, of each person's life, do not answer all the purposes of making us ultimately happy in the love of God, and of our neighbour; and whether they are not, *cæteris paribus*, the same entirely, or at least in all material respects, in those who believe mechanism, who believe free-will, and who have not entered into the discussion of the question at all; or if there be a difference, whether the associations arising from the opinion of necessity, do not tend more to accelerate us in our progress to the love of God, our only true happiness. It appears to me, that the difference is in general very small; also that this difference, whatever it be, is of such a nature as to be a presumption, in favour of the doctrine of necessity, all things being duly considered.

When a person first changes his opinion from free-will to mechanism, or more properly first sees part of the mechanism of the mind, and believes the rest from analogy, he is just as much affected by his wonted pleasures and pains, hopes and fears, as before, by the moral and religious ones, as by others. And the being persuaded, that certain things have a necessary influence to change his mind for the better or the worse, *i. e.* so as to receive more sensible, sympathetic, religious pleasures, or otherwise, will force him still more strongly upon the right method, *i. e.* put him upon inquiring after and pursuing this method.

If

If it be objected, That the moral sense supposes, that we refer actions to ourselves and others, whereas the opinion of mechanism annihilates all those associations, by which we refer actions to ourselves or others; I answer, that it does this just as the belief of the reality and infinite value of the things of another world annihilates all the regards to this world. Both have a tendency to these respective ends, which are indeed one and the same at the bottom; but both require time, in order to produce their full effects. When religion has made any one indifferent to this world, its pleasures and pains, then the kingdom of God, or pure unmixed happiness, comes in respect of him; so that he may then well refer all to God. However, a man may be thoroughly satisfied in a cool deliberate way, that honours, riches, &c. can afford no solid happiness; and yet desire them at certain times, eagerly, perhaps, from former associations. But such a thorough general conviction, applied previously to the particular instances, is a great help in time of temptation, and will gradually destroy the wrong associations. In like manner, the opinion that God is the one only cause of all things, has a tendency to beget the most absolute resignation, and must be a great support in grievous trials and sufferings.

We may shew by a like method of reasoning, that the affections of gratitude and resentment, which are intimately connected with the moral sense, remain notwithstanding the doctrine of mechanism. For it appears from the account of resentment above delivered, that this, and by consequence gratitude, in their nascent state, are equally exerted towards all things, animate and inanimate, that are equally connected with pleasure and pain. By degrees all succeeding circumstances are left out, and our love and hatred confined to preceding ones, which we consider as the only causes. We then leave out inanimate objects entirely, brutes and children in most circumstances, and
adults

adults in some. All which is chiefly done, because acknowledgments, rewards, threatenings, and punishments, with the other associated circumstances of gratitude and resentment, can have no use but with respect to living intelligent beings. By farther degrees we learn such a use of the words, cause, and effect, as to call nothing a cause, whose cause, or preceding circumstance, we can see, denominating all such things mere effects, all others causes. And thus, because the secret springs of action in men are frequently concealed, both from the by-stander, and even from the agent himself, or not attended to, we consider men in certain circumstances as real causes; and intelligent beings, as the only ones that can be real causes; and thus confine our gratitude and resentment to them: whence it seems to follow, that as soon as we discover created intelligent beings not to be real causes, we should cease to make them the objects either of gratitude or resentment. But this is in great measure, speculation; for it will appear to every attentive person, that benevolence, compassion, &c. are amiable, and the objects of gratitude, envy and malice the contrary, from whatever causes they proceed, *i. e.* he will find his mind so formed already by association, that he cannot withhold his gratitude or resentment: and it has been my business in the foregoing analysis of the affections, to point out the several methods by which this and such like things are brought about. And, for the same reasons, a person must ascribe merit and demerit, which are also intimately connected with the moral sense, to created intelligent beings, though he may have a full persuasion, that they are not real causes.

It does indeed appear, that this is owing to our present imperfect state, in which we begin with the idolatry of the creature, with the worship of every associated circumstance; and that as we advance in perfection, the associations relating to the one only, ultimate, infinite cause, must at last overpower all the rest;

rest; that we shall pay no regards but to God alone; and that all resentment, demerit, sin and misery, will be utterly annihilated and absorbed by his infinite happiness and perfections. For our associations being in this, as in many other cases, inconsistent with each other, our first gross and transitory ones must yield to those which succeed and remain.

While any degree of resentment, or displeasing affection, is left, it may be shewn, that the same associations which keep it up, will turn it upon the creatures, and particularly upon ourselves. And, on the other hand, when the consideration of the ultimate cause seems ready to turn it from ourselves, it will also shew that it ought to be annihilated.

These may be considered as general remarks, tending to remove the difficulties arising from the consideration of the moral sense. I will now state the principal objections to the opinion of mechanism, in a direct, but short way, adding such hints as appear to me to afford a solution of them.

First, then, It may be said, that a man may prove his own free-will by internal feeling. This is true, if by free-will be meant the power of doing what a man wills or desires; or of resisting the motives of sensuality, ambition, &c. *i. e.* free-will in the popular and practical sense. Every person may easily recollect instances, where he has done these several things. But then these are entirely foreign to the present question. To prove that a man has free-will in the sense opposite to mechanism, he ought to feel, that he can do different things, while the motives remain precisely the same: and here I apprehend the internal feelings are entirely against free-will, where the motives are of a sufficient magnitude to be evident; where they are not, nothing can be proved.

Secondly, It may be said, that unless a man have free-will, he is not an agent. I answer, that this is true, if agency be so defined as to include free-will. But if agency have its sense determined, like other words,

words, from the associated appearances, the objection falls at once. A man may speak, handle, love, fear, &c. entirely by mechanism.

Thirdly, It may be said, that the denial of free-will in man is the denial of it in God also. But to this it may be answered, that one does not know how to put the question in respect of God, supposing free-will to mean the power of doing different things, the previous circumstances remaining the same, without gross anthropomorphism. It does not at all follow, however, because man is subject to a necessity ordained by God, that God is subject to a prior necessity. On the contrary, according to the doctrine of mechanism, God is the cause of causes, the one only source of all power.

Fourthly, It may be said, that men are perpetually imposed upon, unless they have free-will, since they think they have. But here again free-will is put for the power of doing what a man wills or desires, &c. for, in the sense opposite to mechanism, few persons have ever entered into the discussion of the point at all; and those who do with sufficient attention, cannot but determine against free-will, as it seems to me.

Fifthly, It may be said, that the doctrine of mechanism destroys the notion of a particular providence altering the course of nature so as to suit it to the actions of men. I answer, that laying down philosophical free-will, such an alteration in the course of nature may perhaps be necessary. But if man's actions, and the course of nature, be both fixed, they may be suited to each other in the best possible manner; which is all that can be required, in order to vindicate God's attributes, as well as all that man can desire.

Sixthly, It may be said, that all motives to good actions, and particularly to prayer, are taken away by denying free-will. I answer, that according to the mechanical system, prayer and good actions are the means for obtaining happiness; and that the belief

lie of this is the strongest of motives to impel men to prayer and good works.

Seventhly, It may be said, that the denial of free-will destroys the distinction between virtue and vice. I answer, that this is according as these words are defined. If free-will be included in the definition of virtue, then there can be no virtue without free-will. But if virtue be defined obedience to the will of God, a course of action proceeding from the love of God, or from benevolence, &c. free-will is not at all necessary; since these affections and actions may be brought about mechanically.

A solution analogous to this may be given to the objection taken from the notions of merit and demerit. Let the words be defined, and they will either include free-will, or, not including it, will not require it; so that the proposition, *merit implies free-will*, will either be identical, or false.

Eighthly, It may be said, that the doctrine of mechanism makes God the author of sin. I answer, that till we arrive at self-annihilation, sin always will, and ought to appear to arise from ourselves; and that, when we are arrived thither, sin and evil of every kind vanish. I answer also, that the doctrine of philosophical free-will does not remove our difficulties and perplexities, in respect of the moral attributes of God, unless by transferring them upon the natural ones, *i. e.* by our supposing that some prior necessity compelled God to bestow free-will on his creatures. It seems equally difficult, in every way, to account for the origin of evil, natural or moral, consistently with the infinity of the power, knowledge, and goodness of God. If we suppose, that all tends to happiness ultimately, this removes the difficulty so far as to produce acquiescence in the will of God, and thankfulness to him; and that just as much upon the system of mechanism as that of free-will. Moral evil has no difficulty in it, besides what arises from the natural evil attending it.

Ninthly,

Ninthly, It may be said, that the exhortations of the scriptures presuppose free-will. I answer, That they are to be considered as motives impelling the will, and contributing, as far as they are attended to, to rectify it. A parent who believes the doctrine of mechanism may, consistently with it, or rather must necessarily, in consequence of this belief, exhort his child. Therefore God, who is pleased to call himself our heavenly Father, may do the same. And if we embrace the opinion of universal restoration, then all the exhortations contained both in the word and works of God, will produce their genuine effect, and concur to work in us dispositions fit to receive happiness ultimately.

I come now to hint some consequences of the doctrine of mechanism, which seem to me to be strong presumptions in its favour.

First, then, It entirely removes the great difficulty of reconciling the prescience of God with the free-will of man. For it takes away philosophical free-will, and the practical is consistent with God's prescience.

Secondly, It has a tendency to beget the most profound humility and self-annihilation; since, according to this, we are entirely destitute of all power and perfection in ourselves, and are what we are entirely by the grace and goodness of God.

Thirdly, It has a tendency to abate all resentment against men. Since all that they do against us is by the appointment of God, it is rebellion against him to be offended with them.

Fourthly, It greatly favours the doctrine of universal restoration. Since all that is done is by the appointment of God, it cannot but end well at last.

Fifthly, It has a tendency to make us labour more earnestly with ourselves and others, particularly children, from the greater certainty attending all endeavours that operate in a mechanical way.

Lastly,

Lastly, There are many well-known passages of scripture, which cannot be reconciled to the doctrine of philosophical free-will, without the greatest harshness of interpretation.

It may also be objected to the whole foregoing theory, as well as to the doctrine of vibrations in particular, that it is unfavourable to the immateriality of the soul; and, by consequence, to its immortality. But to this I answer, that I am reduced to the necessity of making a *postulatum* at the entrance of my inquiries; which precludes all possibility of proving the materiality of the soul from this theory afterwards. Thus I suppose, or postulate, in my first proposition, that sensations arise in the soul from motions excited in the medullary substance of the brain. I do indeed bring some arguments from physiology and pathology, to shew this to be a reasonable *postulatum*; when understood in a general sense; for it is all one to the purpose of the foregoing theory, whether the motions in the medullary substance be the physical cause of the sensations, according to the system of the schools; or the occasional cause, according to *Malbranche*; or only an adjunct, according to *Leibnitz*. However, this is not supposing matter to be endued with sensation, or any way explaining what the soul is; but only taking its existence, and connection with the bodily organs in the most simple case, for granted, in order to make farther inquiries. Agreeably to which I immediately proceed to determine the species of the motion, and by determining it, to cast light on some important and obscure points relating to the connection between the body and the soul in complex cases.

It does indeed follow from this theory, that matter, if it could be endued with the most simple kinds of sensation, might also arrive at all that intelligence of which the human mind is possessed: whence this theory must be allowed to overturn all the arguments which are usually brought for the immateriality of the soul from the subtlety of the internal senses,
and

and of the rational faculty. But I no ways presume to determine whether matter can be endued with sensation or no. This is a point foreign to the purpose of my inquiries. It is sufficient for me, that there is a certain connection, of one kind or other, between the sensations of the soul, and the motions excited in the medullary substance of the brain; which is what all physicians and philosophers allow.

I would not therefore be any way interpreted so as to oppose the immateriality of the soul. On the contrary, I see clearly, and acknowledge readily, that matter and motion, however subtly divided, or reasoned upon, yield nothing more than matter and motion still. But then neither would I affirm, that this consideration affords a proof of the soul's immateriality. In like manner the unity of consciousness seems to me an inconclusive argument. For consciousness is a mental perception; and if perception be a monad, then every inseparable adjunct of it must be so too, *i. e.* vibrations, according to this theory, which is evidently false. Not to mention, that it is difficult to know what is meant by the unity of consciousness.

But it is most worthy of notice, that the immateriality of the soul has little or no connection with its immortality; and that we ought to depend upon him who first breathed into man the breath of the present life, for our resurrection to a better. *All live unto him.* And if we depend upon any thing else besides him, for any blessing, we may be said so far to renounce our allegiance to him, and to idolize that upon which we depend.

END OF THE FIRST PART.